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GEOPHYSICS.—*Possibilities and significance of high-speed computing in meteorology.*[1]

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These comments refer to the impressions from a conference on the significance and possibilities of high-speed computing in meteorology and oceanography that was organized under the sponsorship of the National Science Foundation and which met in May 1954 at the University of California in Los Angeles.[2]

Meteorological research is or at least should be of great interest not only to meteorologists but also to physicists, applied mathematicians, astrophysicists, and other scientists. Many important developments in meteorology were brought about through active cooperation between various disciplines. Modern research is often done by applying to a problem theoretical and experimental methods developed by various branches of science. Recognizing these facts, the main purpose of the Los Angeles conference was therefore to bring together meteorologists, oceanographers, mathematicians, and physicists in a round-table discussion on the possibilities as well as the limitations of high-speed computing in meteorology and oceanography. Several participants prepared in advance some comments on various meteorological problems which already are or may be investigated using high-speed computing techniques. These comments helped in leading to an extensive discussion of the applications of numerical methods in meteorology and to an exchange of ideas between the forty or so scientists representing the various disciplines.

Most of the discussion of meteorological problems was concerned with the motions of the atmosphere. The fundamental laws of air motions are based on theoretical and experimental information available from fluid dynamics studies and are applied with much success whenever the flow conditions are relatively simple, as is often the case in physics and engineering. However, in most meteorological problems, the fluid motions are extremely complex and the application of even relatively simplified laws of hydrodynamics would require long computations. The meteorologists have, therefore, of necessity, been forced to build a discipline, based partly on existing physical laws and partly on insight into atmospheric phenomena gained from long experience. While the art of meteorology was thus being continually improved, important advances were being made in fluid dynamics and in pertinent mathematical techniques. High-speed computing techniques came into being and their development opened new possibilities. With this newly acquired knowledge and facilities, a more scientific approach to problems of atmospheric motions could again be attempted. Electronic computing machines can now, within a reasonable time and without requiring thousands of human operators,

[1] Presented at the Tenth General Assembly of the International Union of Geodesy and Geophysics. Reprinted, by permission from the *Scientific Proceedings of the International Association of Meteorology, Rome, 1954*. London (Butterworths), 1955. Some references to the discussions included in the Proceedings are omitted in the present paper.

[2] The participants included F. L. Alt, J. Bjerknes, L. M. K. Boelter, J. Charney, C. Eckart, R. Fjørtoft, G. Forsythe, F. N. Frenkiel, M. R. Hestenes, E. W. Hewson, J. Holmboe, J. Kampé de Fériet, J. Kaplan, W. W. Kellogg, V. O. Knudsen, G. P. Kuiper, J. W. Mauchly, W. H. Munk, J. Namias, M. Neiburger, E. Palmén, H. A. Panofsky, E. R. Piore, G. W. Platzman, R. R. Revelle, R. J. Seeger, Z. Sekera, J. Smagorinsky, H. K. Stephenson, H. J. Stewart, J. J. Stoker, O. G. Sutton, S. Syōno, P. D. Thompson, J. von Neumann, and H. Wexler.

apply such laws to many complicated meteorological problems.

Numerical weather forecast, using high-speed computing equipment, is already an object of extensive studies, particularly in the United States, the United Kingdom, and Sweden. From known meteorological conditions over the United States, for example, the general flow pattern can already be determined, one or two days ahead, for a large part of the country. Comparisons between the numerically determined charts and those observed one or two days later appear to be encouraging. With further scientific development, predictions of large scale flow patterns, located correctly to within, say, 200 miles, will be made soon on a routine basis.

The use of electronic computers has already made great contributions to many fields of science and technology. However, their importance to meteorology is particularly significant. In such problems as weather prediction, the meteorologist does not have the time or the means to apply all those laws of fluid motion which are well known. He therefore makes a general diagnosis of the meteorological situation and determines on its basis his forecast. There is, in such a prediction, some guessing in which experience is necessary and where some luck is helpful. No two human forecasters will reach absolutely the same conclusions. Unlike the human forecaster, the electronic computing machine is completely objective; it will not guess, but it will give results corresponding to the physical laws used as a basis for the numerical forecast. An incorrect forecast will indicate to the meteorologist that his instructions or data to the machine should be improved. Thus a quantitative comparison between the effects of various possible improvements on the numerical weather predictions will be of great value. One should, however, not lose sight of the fact that an electronic computing machine does not have its own intelligence. Its lack of intelligence is responsible for its objectivity which in turn limits the ability of the machine to making relatively simple operations according to a program prepared by human operators. It is only the speed with which the machine performs these computations and the volume of the numerical information it can memorize which make it valuable to a meteorologist. Each *numerical* weather forecast must be followed by a critical interpretation of the results by a synoptic meteorologist who using it as a basis, and taking into account the humidity and temperature distributions, will prepare the *physical* weather forecast. The final weather prediction will largely depend on the experience and ability of the synoptic meteorologist. A part of his work will, however, be done using methods developed in exact sciences. One can see a certain similarity between meteorology and medicine; the electronic computing machine playing the role of such modern medical methods as, say, the determination of sedimentation rates. The diagnosis of a physician, like the diagnosis of a synoptic meteorologist will greatly improve if he uses all the available scientific tools.

The contribution of high-speed computing techniques to weather forecasting consists primarily in making possible the numerical solution of some fundamental equations of fluid dynamics which have been known for many years. However, the theoretical foundations of numerical forecasting also depend on recent contributions to the mathematical representation of atmospheric motions and to numerical analysis. There are, also, some recent advances in fluid dynamics which may, with the help of high-speed computing techniques, contribute to a better understanding of atmospheric motions. I am referring to the statistical theory of turbulence and to the related applications of probability theory. Theoretical and experimental studies of turbulence may be useful in showing where such an approach to meteorology will be of practical value.

The recent development of the statistical theory of turbulence has been influenced by the possibility of comparing the theoretical results to experimental measurements in wind tunnels. Most of these measurements were made with hot-wire anemometers with which velocity fluctuations reaching frequencies of ten thousand cycles per second can be observed. The nature of the turbulent fluctuations is determined by eliminating, with appropriate electronic equipment, the mean wind velocity and expressing the turbulence characteristics by such statistical quantities as correlation coefficients, spectra

of turbulence and turbulence intensities. This electronic equipment operates, in fact, like a specialized analog computing machine determining statistical characteristics of the fluctuating wind velocity. The mean wind-tunnel velocity is well defined, and the fluctuations of the instantaneous velocity correspond to a scale of eddy sizes of the order of one centimeter or smaller. When the mean wind velocity is of at least 1 meter per second, the frequency of turbulent fluctuations is of 100 cycles per second or more. In an analog computing operation, a several second sample record is used which is sufficiently large compared to the magnitude of the fluctuation periods to give meaningful statistical results.

The turbulent energy of the atmosphere includes a certain amount of energy corresponding to eddies of the same range of magnitudes as those of wind-tunnel turbulence. It also includes eddies of several centimeters or meters observed with micrometeorological instruments as well as larger size fluctuations recorded in most meteorological stations on manographs. Eddies of a magnitude of many kilometers and cyclonic motions observed on synoptic charts may be included in the definition of the turbulent energy of the atmosphere. The spectrum of atmospheric turbulence will therefore cover a very large range of eddies. One must have, therefore, a sufficient amount of data on fluctuating wind velocities to be able to compute statistically meaningful averages. Electronic computing machines make such computations possible and enable us to apply some of the methods of the statistical theory of turbulence to atmospheric problems.

The main importance of the modern theory of turbulence is, however, its contribution to the understanding of such physical processes as the transfer of turbulent energy from large scale motion to smaller scale fluctuations and the decay of turbulence. The equations describing these physical processes are based on the laws of fluid dynamics and are known at least in some simple cases of turbulent fields. The use of the statistical description of the turbulent fluctuations is justified here by the fact that it brings these physical processes into focus and is not a means for concealing our ignorance of these processes.

The study of the relation between large-scale flow patterns and the smaller-scale phenomena, which are our local weather, must be based on a better knowledge of atmospheric turbulence. This knowledge can be acquired from extensive atmospheric data obtained under various meteorological and geographic conditions. However, the enormous amount of available data and their extreme complexity make it practically impossible for a meteorologist to digest them and to grasp fully their significance. A large number of already available measurements, therefore, remain unexploited; other significant meteorological data are not even collected because of the labor and time which would be required to analyze them. High-speed computing techniques now make possible the analysis of these data in a reasonable time.

As we have mentioned before, in a wind tunnel it is rather easy to define a constant mean wind velocity and the turbulent velocity fluctuations which depart from this mean. The averaging process is much more difficult in the case of atmospheric turbulence. The definition of a "mean" wind velocity will essentially depend on the scale at which we wish to observe the meteorological motions. There will also be some mathematical difficulties in defining appropriate averages using the experimental data but in this regard one can obtain valuable results from studies of atmospheric spectra of turbulence.

The largest scale at which one can study the atmosphere is the planetary scale. Here the main difficulty is that we cannot observe the Earth's atmosphere as a whole. One may hope that in the future meteorological observations from rockets and artificial satellites may be practicable but at present we have a general view of the atmospheric motions only for our sun and for such planets as Jupiter, Saturn, Mars, and Venus, where some cloud motions or dust storms can be seen. The view from this great distance brings out the large scale motions and averages out the smaller scale spatial fluctuations. To have an even more complete understanding of the planetary circulation one must also bring out the large-scale time trends of the flow patterns by averaging out

the smaller time scale fluctuations. This can be attempted for our own atmosphere by determining an average chart from a large number of synoptic charts. The knowledge and understanding of the planetary circulation are of importance to long-range weather forecasting. In such forecasting the problem is indeed not to determine the location of individual fronts and cyclones but to predict the general trends of atmospheric behaviors over an entire hemisphere. High-speed computing techniques will be of essential importance to such studies of long-range weather forecasting. We may, however, emphasize again the need for understanding the energy transfer from large scale motions to smaller scale fluctuations to which we have referred when discussing the spectrum of atmospheric turbulence. The relation between the general planetary circulation and the large scale "turbulent motions" represented on the individual synoptic charts must also be a subject of a study based on modern fluid dynamic concepts.

Let me at this place digress to quote from the writings of one of the first meteorologists, Aristotle. In his book *Meteorologica*, he writes: "Some people, wishing to be clever, say that all the winds are one, on the ground that the air which moves is in fact one and the same whole, and only seems to differ, without differing in reality, because of the various places from which the current comes on different occasions; which is like supposing that all rivers are but one river. The unscientific views of ordinary people are preferable to scientific theories of this sort" (from an English translation by H. D. P. Lee). As you see, already 23 centuries ago there was some disagreement about the way one should look on the atmosphere. Aristotle's comments projected to our times may have some relation to the statistical considerations of atmospheric motions. It is in fact easy to disagree about the importance of a statistical approach since under the same heading many quite different viewpoints are often included. The use of statistical methods is no doubt of particular importance in meteorological studies. To bring out the planetary circulation, a statistical analysis of the data can be used to eliminate all small spatial or temporal weather fluctuations. Statistical analysis can again be used to study these fluctuations and determine a spectrum of atmospheric turbulence or a correlation curve. The significance of the shape of a spectrum of turbulence or a correlation curve would be based on the physical processes which they appear to represent. In many statistical problems, correlation coefficients are measured and in some of them their value does not add much to the understanding of the physical processes. One can compute a correlation coefficient expressing quantitatively the correctness of a weather forecast. Information theory is providing other methods for such a quantitative study which will also be of value. In many micrometeorological studies one is often concerned with another aspect of a statistical approach in which a correlation curve is significant when it has a connection with the underlying physical process.

Atmospheric pollution of an industrial area has now become a major problem in many communities. Such areas face the problem of reducing the degree of contamination without detriment to many of those human activities that produce it and that are necessary to the well-being of the population. Here again high-speed computing techniques will make possible the application of the laws of physics to the solution of a large part of the problem. The same techniques appear to be of interest to other problems related to turbulent diffusion. Serious consideration is also being given to research on evaporation as well as some problems of sand storms which are of such a great interest to the arid zones studies.

The development and trajectories of tropical cyclones are the object of several studies to which high-speed computing will be very valuable. In this problem one has to solve a system of non-linear equations with certain initial and boundary conditions which involve so many complicated numerical calculations that only electronic computing machines will be able to give practical results. Numerical forecast of the meteorological conditions leading to disastrous floods has been proven to be possible. These and other meteorological problems are of major importance in certain areas and their further study awaits the scientific developments now made possible with the assistance of high-speed computing techniques.

Since there are so many applications for high-speed computing in meteorology, one may ask the question of what is the status of electronic computing machines at present. A large number of electronic digital computers are now in operation and are used to solve meteorological problems. In the Washington area there is now a numerical computing center especially devoted to numerical weather forecast. This center located in Suitland, Md., is jointly sponsored by the Air Force, the Navy, and the Weather Bureau. Most of the meteorological problems and particularly numerical weather forecasting require digital computers of a rather large capacity with a large number of vacuum tubes and complicated electrical circuits. The size and cost of such computers with their relatively large power supplies and cooling systems often limits their availability to many meteorological organizations. There are, however, smaller computing machines which may be of great value to the study of several meteorological problems. I should also like to call attention to the possibility of using transistors in place of vacuum tubes in digital computers. A transistor is of about one tenth of the size of a vacuum tube and requires about one twentieth of its power supply. Although the use of transistors in digital computers is at present at an experimental stage one can expect that it will soon become practical. The installation of the electrical circuitry can also be considerably simplified by using printed circuits. Digital computers with transistors and printed circuits will require smaller power supplies, little or no cooling, and much less space. As a result they will no doubt become less expensive and more accessible to a larger number of meteorological organizations.

One cannot talk about the status of high-speed computing machines without thinking about the processing of data and of the instructions to the machine. I have referred before to the large amount of numerical data which can be analyzed by a digital computing machine. However, the speed with which it performs its operations is often limited by the speed with which the data can be put into the machine. Numerical weather forecasting is particularly concerned with devising techniques for an efficient processing of data to the machine and of the resulting numerical forecast back to the meteorologist.

In conclusion, let me summarize my main impressions from the discussions at the Los Angeles conference. I feel that a closer contact between meteorologists, physicists, mathematicians, and other scientists will be very profitable to the development of Meteorology as a science. High-speed computing techniques have an important role in such a development; their impact will no doubt be felt in several fields of meteorological research. I have the impression that numerical forecasting will influence synoptic meteorology in a very special way, for I believe that what is coming forward is a great development of a modern synoptic meteorology which will connect the synoptic studies to the numerical weather forecast methods. I have already referred to the fact that following a numerical forecast a synoptic meteorologist will have to prepare a physical weather forecast. But of main importance to synoptic meteorology seems to be that, in the future, numerical forecast will be used to construct general weather patterns from which one will be able to determine a weather forecast located correctly within, say, a space scale of 200 miles. These patterns will form a framework which modern synoptic meteorologists, each in his own local area, will complete at an even smaller scale taking into account the atmospheric processes particular to his area. More correct predictions of local weather conditions can be expected to follow such methods. To reach such results it is not necessary to have in each meteorological organization an electronic digital computer nor is it sufficient to have such computers in some meteorological organizations. What is more important is a proper net of data processing equipment and above all a sufficiently large number of modern synoptic meteorologists whose understanding of atmospheric processes will make possible correct predictions of local weather conditions for each area of the size of a county or a city.

MATHEMATICS.—*Commutators of A and A**.[1]

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EDITORIAL NOTE

The commutator $(A, B) = AB - BA$ where A and B represent matrices or other not necessarily commuting operators has played an important role in quantum mechanics. The nonvanishing of the commutator of canonically conjugate operators is the root of the Heisenberg uncertainty principle.

One infers that commutability is not "purely mathematical," but of metamathematical interest. Developments in the theory of higher order commutators may some day find application in physics.

A normal $n \times n$ matrix A is one which commutes with A^*, the transposed complex conjugate of A. Four proofs are given here for the fact (Theorems 1 and 2) shown previously by C. R. Putnam [1] that the relation

$$A(AA^* - A^*A) - (AA^* - A^*A)A = 0$$

already implies that A is normal. Two of these proofs do not use the characteristic roots of the matrix and can therefore be used for more general cases. Another of these proofs is generalized for bounded operators in Hilbert space. For unbounded operators the fact ceases to be true as is shown by the matrix

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 & \cdots \\ 0 & 0 & \sqrt{2} & 0 & \cdots \\ 0 & 0 & 0 & \sqrt{3} & \cdots \\ \cdot & \cdot & \cdot & \cdot & \cdots \end{pmatrix}.$$

Denoting $AB - BA$ by (A, B) it is shown that the above theorem when combined with another result of C. R. Putnam, (see [2]), implies the following more general theorem: for a non normal matrix A the commutators (A, A^*) and $(A, (A, A^*))$ do not commute.

Finally, the case $n = 2$ is examined. It is shown that the commutator

$$(A, (A, (A, A^*)))$$

is proportional to (A, A^*). If $(A, (A, \cdots, (A, A^*) \cdots))$ is called the nth order commutator if $n - 1$ brackets ( ) are used, it is shown that the fourth order commutator vanishes if A has a double characteristic root, otherwise no commutator of order >4 vanishes for a not normal 2×2 matrix.

Theorem 1. Let A be a finite matrix with elements in a formally real field or in a field with an involution $a \to \bar{a}$, *for which* $\sum a_i \bar{a}_i = 0$ *implies* $a_i = 0$. *Let* $(A, (A, A^*)) = 0$. *Then* $(A, A^*) = 0$.[2]

First proof. This theorem follows from the following more general one.

Theorem 1'. Let A and C be finite matrices satisfying the conditions of Theorem 1. Then $(A, (A^*, C)) = 0$ *implies* $(A^*, C) = 0$.

Proof of Theorem 1'. Put $B = (A^*, C)$ and assume $(A, B) = 0$. Consider trace B^*B. We obtain trace B^*B = trace $((C^*A - AC^*)B)$ = trace C^*AB − trace AC^*B = trace C^*AB − trace $C^*BA = 0$. Hence trace $B^*B = 0$ which implies that all elements of B are 0.

Theorem 1' further implies that for non normal matrices A all "alternating" commutators

$$(A, (A^*, (A, (A^*, \cdots (A, (A^*, (A, A^*))) \cdots)))) \neq 0.$$

Second proof. From Lemma 2 of Jacobson [4], it follows that $AA^* - A^*A$ is nilpotent. Since this commutator is hermitian it is actually the zero matrix. For, let $B^r = 0$ for B hermitian. If $r = 2$ the vanishing of the elements of the principal diagonal of B^2 implies already that $B = 0$ for the type of field considered. If $r > 2$ use the relation $B^{r+s} = 0$ where $s > 0$ and $r + s$ is a power of 2. It follows again that $B = 0$.

Theorem 2. Let A be a finite matrix with

[1] This work has been supported (in part) by the Office of Naval Research.

[2] This theorem can be applied to matrices whose elements are polynomials with real coefficients of several indeterminates, e.g., group matrices (see [3]). This note arose in connection with the study of such matrices. In [3] groups with normal group matrices were characterized. Theorem 1 shows that they coincide with groups of which the 3rd order commutator of the group matrix vanishes. This can also be shown directly by group theoretical methods.

complex numbers as elements. Then

$$(A, (A, A^*)) = 0$$

implies $(A, A^*) = 0$.

First proof. The following two results are used:

1. Two matrices A and B are called quasi-commutative if[3]

$$(A, (A, B)) = (B, (A, B)) = 0.$$

Such a pair of matrices have property P, i.e., they can be transformed to upper triangular form simultaneously by a unitary similarity transformation.

2. If A and A^* have property P then A is normal (see [7]).

It is clear that $(A, (A, A^*)) = 0$ implies quasi-commutativity for A and A^*. Hence Theorem 2 follows.[4]

Second proof. Since $B = (A, A^*)$ is hermitian it can be transformed to diagonal form by a unitary similarity transformation. Since the relations $B = (A, A^*)$ and $(A, B) = 0$ are unchanged under a simultaneous transformation of A, A^* and B by the same unitary matrix, we may assume that B is already in diagonal form.

Suppose now that $B \neq 0$. Then we may assume that there is an integer m $(0 < m \leqq n)$ such that the first m diagonal elements of B are equal to some $\lambda \neq 0$ while the other diagonal elements are different from λ. Then $(A, B) = 0$ implies that A has only zeros for all (i, k) elements with $i \leqq m < k$ or $k \leqq m < i$. Let A_0 be the $m \times m$ matrix composed of the first m rows and columns of A, and B_0 similarly defined. Then $B = (A, A^*)$ implies $B_0 = (A_0, A_0^*)$. This gives a contradiction, for, while the trace of (A_0, A_0^*) is zero, that of B_0 is equal to $m\lambda \neq 0$.

Theorem 3. Let A be a 2×2 matrix with complex numbers as elements and with characteristic roots λ_1, λ_2. Then

$$(A, (A, (A, A^*))) = (\lambda_1 - \lambda_2)^2 (A, A^*).$$

[3] See [5], [6].

[4] This proof can, roughly speaking, be looked upon as the finite dimensional analogue of Putnam's proof. The concept of quasi-commutativity for operators was also studied by Halmos [8] and Kaplansky; see [9], [10].

Proof.[5] This theorem follows from the more general identity concerning any pair A, B of 2×2 matrices which can be verified by actual computation:

$$(A, (A, (A, B))) = [(\text{trace } A)^2 - 4 \det A] (A, B).$$

We now show how the second proof of Theorem 2 can be generalized to bounded operators.

Theorem 4. Let A be a bounded linear operator defined everywhere in a Hilbert space, and let A^* be its adjoint. Then

$$(A, (A, A^*)) = 0$$

implies $(A, A^*) = 0$.

Proof. $B = AA^* - A^*A$ is a bounded, self-adjoint operator. Let $B = \int \lambda d E_\lambda$ be its spectral representation. Let $\mathfrak{M}_\lambda$ be the range of the projection $I - E_\lambda$, where $\lambda > 0$. Then $(A, B) = 0$ implies that $\mathfrak{M}_\lambda$ reduces both A and A^*.[6] Let A_λ and A_λ^* be the parts of A and A^* on $\mathfrak{M}_\lambda$ respectively. It is easily seen that A_λ^* is equal to $(A_\lambda)^*$. We have $(A_\lambda, A_\lambda^*) = B_\lambda$, where B_λ is the part of B on $\mathfrak{M}_\lambda$. Hence $A_\lambda A_\lambda^* - A_\lambda^* A_\lambda \geqq \lambda I_\lambda > 0$ by construction where I_λ is the identity operator in $\mathfrak{M}_\lambda$. Let x be any vector. It follows that $\| A_\lambda x \|^2 \leqq \| A_\lambda^* x \|^2 - \lambda \| x \|^2 \leqq (\| A_\lambda^* \|^2 - \lambda) \| x \|^2$ where $\| A_\lambda^* \|$ is the bound of A_λ^*. This would lead to the contradiction $\| A_\lambda \|^2 \leqq \| A_\lambda^* \|^2 - \lambda < \| A_\lambda^* \|^2 = \| A_\lambda \|^2$ unless $\mathfrak{M}_\lambda$ is zero-dimensional. Thus we have proved that $I - E_\lambda = 0$ or $E_\lambda = I$ for $\lambda > 0$. Similarly we can show that $E_\lambda = 0$ for $\lambda < 0$. This completes the proof of $B = 0$.

Theorem 2 and Theorem 4 can be generalized by using the following theorem of C. R. Putnam (see [2]):

Let A be a bounded matrix and B be a bounded normal matrix. If $(A, B) = C$ and $(B, C) = 0$ then $C = 0$.

Using this theorem for $B = (A, A^*)$ and Theorems 2 and 4, we obtain:

Theorem 5. For a bounded matrix A in Hilbert space the commutators (A, A^*) and $(A, (A, A^*))$ commute if and only if A is normal.

[5] K. Goldberg assisted us in this proof. See also [11].

[6] See [12], pp. 25 and 33.

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MISCELLANY

Your Editor's mail included the following letter on a problem of general interest. The appended news items on the subject indicate encouraging progress.

A SOLUTION TO THE "SCIENTIST PROBLEM"

Since so much alarmed attention is being given to the present and future shortage of really good science teachers and, ergo, of trained scientists, this solution might be presented: a rotating supply of teachers recruited from competent scientists now working in government, industry, and the Armed Forces.

This might be organized on a one- or two-year "sabbatical leave" basis with the present employer and/or Federal Government and/or foundations continuing that part of the scientist's normal salary and expenses which the public-school system or college is unable to pay. If a man qualified to teach some phase of science is inducted into the Armed Forces, he could serve as a teacher under this plan in lieu of military service.

Since every scientist, however competent, would not necessarily be equipped to *teach* his or her subject, probably a brief period of orientation in planning, psychology, and course requirements would be necessary before entering the school system. This could be given in the form of short seminars at colleges or at central cities, by teachers "borrowed" from colleges.

Figures might be cited on the number of scientists in various fields who could contribute to such a plan. It would be intersting if statements could be quoted from leaders in government, industry, and the Armed Forces on the practical possibilities of the idea; also from educational leaders on the plan's apparent advantages (such as the value of instruction from expert "practicing" scientists and the drawing power science courses would have under such teachers), and from scientists on their willingness to participate in such a plan, their recognition of the seriousness and immediacy of the problem, and their present inability or reluctance to teach because of the financial (and, possibly, professional status) sacrifice now involved.

Opinions might be gathered concerning under what agency this could best be organized (government? one of the foundations?) and where such teaching influence is most important (high school, college, or combination of both?).

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TRAINING PROGRAM FOR SCIENCE AND MATHEMATICS TEACHERS IN SECONDARY SCHOOLS

The National Academy of Sciences-National Research Council in cooperation with the American Association for the Advancement of Science and with the encouragement of major groups in business and industry is setting up a supplementary training program for science and mathematics teachers in secondary schools. This group

is considered the most important segment of the American educational system, because largely upon them depends the interest and preparation of today's students who may be tomorrow's scientists, engineers, and technicians.

Arlington County, Va., is being used as a model for a pilot study on ways and means of improving the caliber of science and mathematics teaching in public schools. Other school systems in the Washington area have been invited to participate. School boards, parent-teachers associations, and civic groups are cooperating to raise a scholarship fund which will enable teachers to take graduate-level courses and familiarize themselves with both the fundamentals and recent developments in Sciences.

Another aspect of the plan provides qualified teachers with opportunities for summer employment in local scientific and engineering organizations in both industry and government.

On October 27, representatives of The George Washington University, University of Maryland, University of Virginia, American University, Georgetown University, Catholic University, Howard University, and District of Columbia Teachers' College met at the Academy-Research Council to develop a joint program of special courses in mathematics, physics, chemistry, and biology for the summer of 1956. A committee on the improvement of science and mathematics teaching, composed of representatives of the participating universities, is being formed to help coordinate the plans for this cooperative effort.

Responsibility for the general supervision of the entire program will be assigned by the Academy-Research Council to a special board representing all areas of science, mathematics and engineering.

Shell Companies Foundation, Inc., has initiated a program of *Shell Merit Fellowships for High School Science and Mathematics Teachers*. Under the program, Shell will underwrite seminars for 60 teachers each summer. The study program will include graduate-level classes, lectures by outstanding scientists, and visits to research laboratories and industrial facilities. Cornell and Stanford Universities will operate the seminars.

Recipients of these fellowships will receive travel allowance, living expenses, tuition and fees, plus $500 to compensate other potential summer earnings.

PALEONTOLOGY.—*New families of Gastropoda*. J. BROOKES KNIGHT, Smithsonian Institution.

The writer is senior author of a manuscript for those portions of Parts I and J of the *Treatise on invertebrate paleontology* that deal with the Monoplacophora and with the Paleozoic Gastropoda. The junior authors are Dr. Roger L. Batten and Dr. Ellis L. Yochelson. It was found that a not inconsiderable number of new taxa in the familial group were needed. Although exceptions have been made, it is thought that the *Treatise* is not an appropriate place for the publication of the names of new taxa. Likewise the authors feel that names published with more than two authors place an unnecessary burden on posterity and should be avoided if possible. If new names were published in the *Treatise* it would have been necessary to cite Knight, Batten, and Yochelson as authors, unless recourse was had to the always clumsy and often confusing expedient of citing authorship for individual names of new taxa different from that of the paper as a whole.

These considerations have led the joint authors to agree that the senior author, Knight, publish the new taxa of most of the familial group in advance of the appearance of the *Treatise*. Since the full systematic treatment and full diagnoses of these taxa will appear within the year and since diagnoses are not requisite for validity of familial names, though recommended (Follett, 1955, p. 5 [38, 42]), they are omitted here.

Certain other names for new families, new genera, and new species will also be published separately in advance of the *Treatise* by the junior authors and by two others, Dr. Stephen S. Winters and Dr. Arthur J. Bou-

cot, both of whom have papers in preparation containing taxa important to the *Treatise*. In the following list names ending in -acea apply to superfamilies, in -idae to families, in -inae to subfamilies, and in -ides to tribes.

Familial name	*Type genus*
Agnesiinae	*Agnesia* Koninck, 1883.
Archinacellidae	*Archinacella* Ulrich and Scofield, 1897.
Coelozoninae Coelozonides	*Coelozone* Perner, 1907.
Elasmonematidae	*Elasmonema* Fischer, 1885.
Euphemitinae	*Euphemites* Warthin, 1930.
Gyronematinae	*Gyronema* Ulrich, 1897.
Hypseloconidae	*Hypseloconus* Berkey, 1898.
Liospirinae	*Liospira* Ulrich and Scofield, 1897.
Luciellidae	*Luciella* Koninck, 1883.
Meekospiridae	*Meekospira* Ulrich, 1897.
Knightitinae	*Knightites* Moore, 1941.
Neilsoniinae	*Neilsonia* Thomas, 1940.
Ophiletinae	*Ophileta* Vanuxem, 1842.
Palaeotrochacea Palaeotrochidae	*Palaeotrochus* Hall, 1879.
Pelagiellacea Pelagiellidae	*Pelagiella* Matthew, 1895.
Phanerotrematidae	*Phanerotrema* Fischer, 1885.
Plagiothyridae	*Plagiothyra* Whidborne, 1892.
Planitrochidae	*Planitrochus* Perner, 1903.
Planozonides	*Planozone* Perner, 1907.
Platyschismatinae	*Platyschisma* M'Coy, 1844.
Progalerinae	*Progalerus* Holzapfel, 1895.
Rhaphischismatidae	*Rhaphischisma* Knight, 1936.
Ruedemanniinae	*Ruedemannia* Foerste, 1914.
Tropidodiscinae	*Tropidodiscus* Meek and Worthen, 1866.
Tubinidae	*Tubina* Owen, 1859.
Turbonellininae	*Turbonellina* Koninck, 1881.

REFERENCE

FOLLETT, W. I. *An unofficial interpretation of the International Rules of Zoological Nomenclature as amended by the XIII International Congress of Zoology, Paris 1948 and by the XIV International Congress of Zoology Copenhagen, 1953.* Society of Systematic Zoology, 1955.

PALEONTOLOGY.—*Some new pleurotomarian gastropods from the Permian of west Texas.* ROGER L. BATTEN, University of Wisconsin. (Communicated by John B. Reeside, Jr.)

Five new genera and two new families of upper Paleozoic gastropods have thus far been recognized by the writer during a study of Permian pleurotomarians from west Texas and New Mexico. The purpose of this present paper is to make available the resulting new names for the forthcoming *Treatise on invertebrate paleontology*, since no new names can be included in that work. The new genera and families will be treated and illustrated in greater detail in a paper to appear shortly.

PORTLOCKIELLIDAE Batten, n. fam.

Description.—Characterized by dominant, usually rather coarse spiral ornament and a selenizone low on the whorls; shell shape ranging from globose to turreted; ornament on parietal surface resorbed or covered by a very thin inductura.

Tapinotomaria Batten, n. gen.

Type species.—*Tapinotomaria rugosa* Batten, n. sp.

Description.—Turbiniform pleurotomarians with rounded to steplike whorls and dominant spiral ornament separated by concave interspaces; collabral ornament forms rounded to elongated nodes at intersections with spiral ornament; selenizone defined by a thread with a spiral cord above this thread and commonly with a gap between the cord and the next cord above it; slit shallow.

Tapinotomaria rugosa Batten, n. sp.

Holotype.—U.S.N.M. no. 125281, U.S.N.M. Locality 702d, Leonard formation, Glass Mountains, Texas.

Description.—Whorl profile even and convex to selenizone; spiral and collabral ornament form nodes varying in degree of emphasis; 4 to 6 spiral cords above the selenizone and 4 to 14 spiral cords on the base.

PHYMATOPLEURIDAE Batten, n. fam.

Description.—Discoid to moderately high spired, highly ornamented pleurotomarians with a selenizone located at or slightly above the periphery; the outer whorl face vertical or sloping and may be narrow compared to upper whorl surface; selenizone convex to concave and usually strongly bordered; there may be basal sinuses; ornament in the parietal lip resorbed.

Callitomaria Batten, n. gen.

Type species.—Callitomaria stanislavi Batten, n. sp.

Description.—Turreted pleurotomarians with dominant spiral ornament and step-like whorls, moderately wide selenizone situated about midway on an almost vertical outer whorl face; outer whorl face generally narrower than upper whorl surface; a spiral thread or cord present between suture and upper selenizone margin and one just above selenizone margin; collabral ornament variable in development from suture to base; shallow slit; thin shell.

Callitomaria stanislavi Batten, n. sp.

Holotype.—A.M.N.H. no. 27953, A.M.N.H. Locality 512, Getaway formation, Guadalupe Mountains, Texas.

Description.—Collabral ornament coarse and variable, may be very strong forming nodes above selenizone or on base only or both; spiral elements equally well developed above and below selenizone.

Discotomaria Batten, n. gen.

Type species.—Discotomaria basisulcata Batten, n. sp.

Description.—Discoid to low spired pleurotomarians with a concave selenizone depressed beneath the surface of an almost vertical outer whorl face; upper whorl surface concave with dominant collabral cords; upper edge of outer whorl face unornamented or with nodes and threads; outer whorl face concave, ornamented by collabral elements except for selenizone and a narrow trough just beneath the selenizone; labral sinus complex and moderately deep and slit narrow; trough on outer edge of base with sinus; columellar lip with sinus at upper end.

Discotomaria basisulcata Batten, n. sp.

Holotype.—U.S.N.M. no. 125280, U.S.N.M. locality 702, Leonard formation, Glass Mountains, Texas.

Description.—Early whorls are flat and unornamented; upper whorl surface with very strong collabral cords that form strong nodes at upper edge of outer whorl face; a flat collabrally ornamented shelf forms upper surface of the large, rounded and reticulate lower edge of outer whorl face.

Family **Eotomariidae** Wenz, 1938

Subfamily **Eotomariinae** Wenz, 1938

Tribe **Ptychomphalides** Wenz, 1938

Description.—Turbiniform to trochiform pleurotomarians with dominant collabral ornament and the selenizone situated on the periphery or slightly above it; pronounced cords restricted to a few species only; depth of the slit is variable; selenizone margin complex consisting of several components in some species closely or widely spaced, the lower selenizone margin tending to be wider and more complex.

Shwedagonia Batten, n. gen.

Type species.—Shwedagonia elegans Batten, n. sp.

Description.—Characterized by a very deep, narrow slit extending about eight-tenths of a whorl in depth; selenizone located just above a shallow trough above the periphery; shell shape varies from straight-sided to concave-sided; dominant collabral ornament, usually more pronounced above the selenizone; a flat area just under selenizone bordered below by a turned up margin similar to the upper margin of selenizone; base is smooth to coarsely ornamented; umbilicus wide and with deep sutures.

Shwedagonia elegans Batten, n. sp.

Holotype.—U.S.N.M. no. 125279, U.S.N.M. Locality 703b, Leonard formation, Glass Mountains, Texas.

Description.—Well developed collabral ornament usually more strongly developed above selenizone; spiral ornament consists of fine threads both above and below selenizone; shell shape extremely variable, ranging from very low spired concave sided to moderately high spired straight sided.

Eirlysia Batten, n. gen.

Type species.—Eirlysia exquisita Batten, n. sp.

Description.—Globose trochiform to moderately spired pleurotomarians with a relatively wide selenizone just above periphery; whorls inflated and smooth to selenizone; collabral ornament may be dominant above selenizone but spiral ornament frequently present and weakly developed; slit shallow, selenizone defined by two sharp cords, which may be composed of multiple

elements; a trough is usually developed just below selenizone, lower edge of outer whorl face a cord separating it from flat to flatly rounded base; parietal inductura thin; narrowly to widely phaneromphalus; reflexed columellar lip.

Eirylsia exquisita Batten, n. sp.

Holotype.—U.S.N.M. no. 125282, Princeton University locality 3, Bone Spring formation, Sierra Diablo, Texas.

Description.—Relatively low spired forms with globose whorls; dominant collabral cords from suture to selenizone; selenizone relatively wide and selenizone margins sharply defined; spiral threads are visible both above and below selenizone; lower edge of outer whorl face is sharply defined; narrowly phaneromphalus.

PALEONTOLOGY.—*New Permian gastropod genera from eastern Arizona.* STEVEN S. WINTERS, Florida State University. (Communicated by J. Brookes Knight.)

The following generic names and diagnoses are published so that they might be available for the *Treatise on invertebrate paleontology*, part I. Full discussion with illustrations will be forthcoming at some later date as part of a stratigraphic-paleontological study of the Permian in eastern Arizona. The three new genera, *Apachella*, *Cibecuia*, and *Kinishbia*, are based on silicified material collected from the Fort Apache limestone (Permian) in eastern Arizona on the Fort Apache Indian Reservation.

Family PLEUROTOMARIIDAE Swainson, 1840

Apachella Winters, n. gen.

Type species.—*Apachella translirata* Winters, n. sp.

Description.—Small, moderately high spired turbiniform, less commonly pupiform gastropods with wide, steeply sloping selenizone and flatly rounded, anomphalous, or narrowly phaneromphalous base; initial whorl planospirally coiled; selenizone above peripheral carina flat to concave, generated by a wide slit of moderate depth; aperature ovate to circular; outer lip trending obliquely backward to slit, then with slight forward convexity to nearly vertical columellar lip; parietal inductura thin; parietal tooth in some species extends down from top of aperture; upper whorl profile in some species modified by subsutural shoulder, various revolving carinae and lirae common to all species; transverse ornamentation, when present, limited to upper whorl surface.

Apachella translirata Winters, n. sp.

Holotype.—A.M.N.H. no. 27999/1: 1.

Description.—Turbiniform gastropods with well-developed subsutural shoulder; initial whorl planospirally coiled; whorl profile below subsutural shoulder sloping outward to steeply sloping selenizone carine, then turning to vertical, concave flank, which rounds smoothly into flatly rounded, minutely phaneromphalous base; shallow sinus; columellar lip slightly reflexed; ornament 9 to 10 strong, revolving carinae on base bordering selenizone and well-developed transverse, rounded and closely spaced lirae on subsutural shoulder; first three whorls without ornamentation.

Family MURCHISONIIDAE Koken, 1896?

Cibecuia Winters, n. gen.

Type species.—*Cibecuia cedarensis* Winters, n. sp.

Description.—Small, high-spired, many-whorled conical gastropods with wide, flat selenizone located about midway between upper suture and peripheral keel marking basal angulation; first four whorls smooth; base flatly rounded, anomphalous; outer lip thin, with sinus culminating in notch of unknown depth at midwhorl face; outer lip curves backward with forward convexity above selenizone; below selenizone curves gently forward with forward convexity to keel and across base to thick inner lip, smoothly concave outward; parietal inductura thin or absent; ornament parallel grooves bordering selenizone, with peripheral keel and revolving lirae on base; transverse nodes when present on upper whorl face only.

Cibecuia cedarensis Winters, n. sp.

Holotype.—A.M.N.H. no. 28007/2: 1.

Description.—Small, high-spired, many-whorled, conical gastropods with straight, gently tapered silhouette; sutures incised and impressed below peripheral, keeled angulation separates

whorl face from flatly rounded, slightly extended, anomphalous base; outer lip thin, with sinus culminating in notch of unknown depth at mid-whorl face generating a wide, flat selenizone; revolving ornament of a pair of grooves delimiting selenizone, a faintly noded peripheral keel and 3 or 4 lirae on base; transverse ornament rounded nodes on upper part of whorl face beyond fourth whorl extending downward with slight backward obliquity.

Family LOXONEMATIDAE Koken, 1889

Kinishbia Winters, n. gen.

Type species.—*Kinishbia nodosa* Winters, n. sp.

Description.—Small to medium, high-spired, many-whorled conical gastropods with smooth extended base and narrow umbilicus; outer lip thin, columellar lip thick and nearly vertical, parietal lip nearly horizontal; shallow anterior notch; earlier whorls developing concave profile of tapered spire; strongly developed, rounded transverse costae on upper whorl face of all but first four smooth whorls.

Kinishbia nodosa Winters, n. sp.

Holotype.—A.M.N.H. no. 28011/1: 1.

Description.—Gastropods with whorl profile convex or gently shouldered in upper half, flat and sloping slightly inward in lower half to slight keel separating whorl face from smoothly rounded, somewhat flattened base; outer lip thin with broad, very gentle sinus on flank, crossing base with slight forward convexity to shallow anterior notch; inductura absent; pleural angle varying from 22° to 31°; ornament of transverse costae on upper whorl face and at keel.

PALEONTOLOGY.—Labridens, *a new Permian gastropod.*[1] ELLIS L. YOCHELSON U. S. Geological Survey. (Communicated by James S. Williams.)

Examination of the large collections of fossils from the Permian of western Texas in the U. S. National Museum has revealed a new genus of gastropods. The gastropod, here named *Labridens*, has one unusual character that distinguishes the genus and suggests some interesting implications as to phylogeny.

Labridens is similar to genera placed in the Subulitacea in possessing a siphonal notch and folds on the inner lip and is referred to that superfamily. *Labridens* differs from other subulitaceans and from other Paleozoic gastropods in possessing a lira on the inner surface of the outer lip. As the shell grew, this lira moved forward and formed a spiral ridge inside of the shell.

Lirae and elaborate thickening on the inner surface of the outer lip and throughout the shell are important characteristics of the Nerinacea. This group is common in the Jurassic and Cretaceous, but is unknown elsewhere in the geologic record. Although the shell form of many nerinacean genera is different from that of *Labridens*, a few genera, for example *Brouzetia* Cossmann, approach it. Most nerinaceans have a short canal and at least one columellar fold.

[1] Publication authorized by the Director, U. S. Geological Survey.

The available evidence does not necessarily indicate relationship of the Nerinacea with the Subulitacea, but it is suggestive. Should further evidence of relationships between the Subulitacea and Nerinacea be found, certain major changes in phyletic interpretation will be required, as the Nerinacea are presently classed in the order Mesogastropoda (subclass Prosobranchia) by Wenz (1938, p. 46), and the Subulitacea are classed in the order Archaeogastropoda by Wenz, (1938, p. 44) and in the order Neogastropoda by Knight (1944, p. 477).

Class GASTROPODA

Order NEOGASTROPODA

Superfamily SUBULITACEA

Family SUBULITIDAE

Labridens Yochelson, n. gen.

Type species.—*Labridens shupei*, Yochelson, n. sp.

Diagnosis.—Turbinate gastropods with a strong lira on inner surface of outer lip and one or more columellar plications; whorl profile simple, with gently inflated whorls; without ornament; a strong, sharp lira developed on the inner surface of outer lip; inner lip with basal notch, probably functional as a siphon, and one or more folds above.

Labridens shupei Yochelson, n. sp.

Description.—Moderately high-spired, turbinate, anomphalous gastropods with two folds on inner lip and a lira on inner surface of the outer lip; earliest whorls not certainly known, but probably simple and smooth; suture shallow, but distinct; outer whorl surface flattened, very gently inflated between sutures; surface smooth, ornamented only by exceedingly obscure growth lines; base of columella with a siphonal notch; inner lip with a distinct groove for a short distance above siphonal fold, limited above by a fold extending outward as a flange, the lip above this flange with a wide, shallow groove in turn limited by a second, less distinct, plication, the inner lip above this plication being gently convex above to juncture with outer lip; inner surface of outer lip bearing a low, strong lira approximately across from higher plication on inner lip.

FIG. 1.—*Labridens shupei*, n. sp.: *a*, Apertural view showing folds of inner lip and lirae on inner surface of outer lip; *b*, adapertural view. The tip of the siphonal fold has been broken so that it appears as a notch. ×3.

Discussion.—The outer lip is broken back on all specimens examined but the revolving ridge is fully developed at a point probably no more than one-eighth of a whorl behind the unbroken aperture. The upper plication on the inner lip is obscure near the aperture, but is somewhat more distinct one-half whorl back. Examination of broken specimens indicates that the ridge on the outer lip is not resorbed; similar observation could not be made on the columellar plications.

Labridens shupei is known from a dozen specimens found at three localities in the upper part of the Leonard and lower part of the Word formations of the Glass Mountains. The holotype (U.S.N.M. no. 119556) and an unfigured paratype (U.S.N.M. no. 119557) were collected at U. S. National Museum locality 703. This locality is in a platy limestone in the first limestone member of the Word formation, near the top of a slope half a mile southwest of road forks just northeast of the old Word Ranch House, Hess Canyon quadrangle, Brewster County, Tex.

The species is named for Nelson W. Shupe, U. S. Geological Survey, Paleontology and Stratigraphy Branch, who for many years has contributed superb photographs of fossils to the reports of Geological Survey paleontologists.

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WENZ, WILHELM. *Handbuch der Paläozoologie* (Herausgegeben v. Schindewolf), Bd. 6, *Gastropoda*, Teil 1, Allgemeiner Teil und Prosobranchia (pars). Berlin, 1938.

PALEONTOLOGY.—Gyrospira, *a new genus of bellerophontid (Gastropoda) from Bolivia.*[1] A. J. BOUCOT, U. S. Geological Survey. (Communicated by G. Arthur Cooper.)

Class GASTROPODA

Order ARCHAEOGASTROPODA

Family BELLEROPHONTIDAE

Subfamily CARINAROPSINAE

Gyrospira Boucot, n. gen.

Type species.—*Gyrospira tourteloti* Boucot, n. gen. and n. sp.

Diagnosis.—Widely disjunct bellerophontid Gastropoda; aperture flaring widely both posteriorly and laterally, lacking apertural plate, but bearing median carina internally on posterior face; revolving ornament lacking; possessing median carina, the locus of deep slit.

Comparison.—Genus has flaring aperture, phaneromphalous spire, and posterior, internal carina that characterize members of the Carinaropsinae.

Carinaropsis is most closely related to *Gyrospira*, but the former is more closely coiled. *Gyrospira* is more openly coiled and lacks the revolving ornament that characterizes both *Bucanopsis* and *Phragmosphaera*. *Gyrospira* has less

[1] Publication authorized by the Director, U. S. Geological Survey.

lateral flaring of the aperture and it lacks the apertural plate of *Phragmosphaera*. *Phragmosphaera* lacks the internal carina characteristic of *Gyrospira*. *Sphaenosphaera* possesses an incipient apertural plate and is also more closely coiled than *Gyrospira*.

Gyrospira tourteloti Boucot, n. sp.
Figs. 1–5

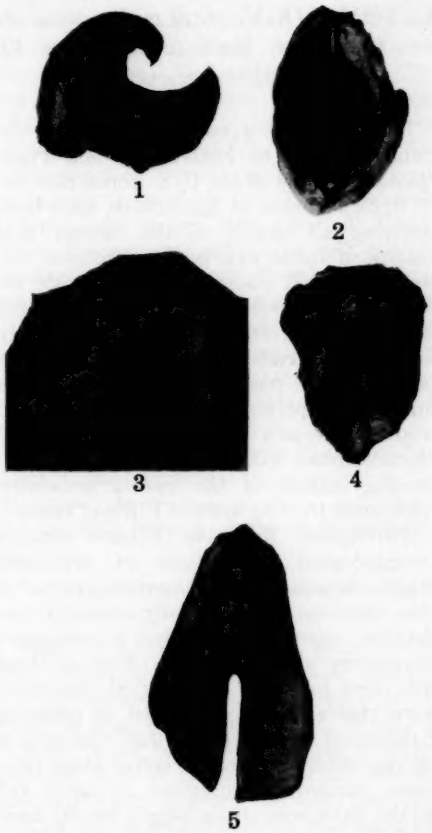
Description.—Medium-sized, openly coiled, widely phaneromphalous, spiral gastropod with wide flaring of posterior and anterior portions of aperture, deep slit in anterior lip culminating in carina; slit about one-third of whorl in depth. Whorl profile on either side of median carina steep, convex over lateral slopes and rounded in open umbilicus; surface with obscure collabral undulations; nucleus and first whorl barely in contact; apertural margin with no anterior flaring but flaring widely posteriorly and moderately on lateral portions of the aperture; posterior median carina on interior of shell (this carina not caused by impression of earlier whorl as whorl is free); ornamentation of undulating concentric growth lines which interrupt otherwise smooth surface of shell; shell moderately thick, its structure unknown.

Occurrence.—The following locality description was provided by H. A. Tourtelot: Measured stratigraphic section (bed 8) beginning at Chacorillo farm and extending nearly a kilometer to the west. Chacorillo farm is about 6 kilometers north of Kilometer 65 of the Potosí-Sucre road; Kilometer 65 is about 15 kilometers east by road from the village of Betanzos, which is 50 kilometers from Potosí, Province of General de Saavedra, Department of Potosí, Bolivia. This locality is U.S.G.S. Silurian and Devonian catalog #3137. Addition material was collected from nearby float (U.S.G.S. Silurian and Devonian catalog no. 3139).

The specimens are preserved as casts and molds in rusty weathering, brown sandstone.

Geologic range.—Carinaropsids have a known range of Middle Ordovician to Devonian. Prof. Harry Whittington, of Harvard University, who kindly examined the associated trilobites, reports (comm. 1955) the presence of *Leiostegina inexpectons*, which suggests to him a correlation with beds of Caradoc age (Black River and Trenton). Dr. David Nicol, of the U. S. National Museum (written communication, 1955), considers that the associated pelecypod material indicates a Middle Devonian age based on the presence of *Parallelodon*, *Modiomorpha*, *Ctenodonta*, and *Grammysia*. The one fragmentary brachiopod present in the material indicates a post Early Ordovician age.

Inasmuch as the trilobites of early Paleozoic age are better known than the pelecypods it seems to the writer that a Middle Ordovician age is the most reliable assignment that can be made under the circumstances.



FIGS. 1–5.—*Gyrospira tourteloti* Boucot, n. gen. and n. sp.

1, Latex impression of exterior (holotype) (×1). Note the widely disjunct coiling and the posteriorly flaring aperture, and the obscure collabral undulations. U.S.N.M. no. 125457.

2, Latex impression of interior (×1). Note the prominent ridge on the posterior portion of the aperture. U.S.N.M. no. 125458A.

3, Latex impression of exterior (×2). Note the nucleus in contact with the first whorl. U.S.N.M. no. 125458C.

4, Latex impression of exterior (holotype) (×1) (dorsal view). Note the prominent median carina on the anterior margin. U.S.N.M. no. 125457.

5, Latex impression of anterior margin and slit (×2). Note the deep slit and raised selenizone. U.S.N.M. no. 125458B.

Holotype.—U.S.N.M. no. 125457.

Figured paratypes.—U.S.N.M. nos. 125458 A-C. *Unfigured paratypes.*—U.S.N.M. nos. 125459, 125460 (U.S.G.S. Silurian and Devonian catalog no. 3139).

ENTOMOLOGY.—*Gall midges associated with cones of western forest trees (Diptera: Itonididae).* RICHARD H. FOOTE, Entomology Research Branch, United States Department of Agriculture.

For a number of years, personnel of the former Bureau of Entomology and Plant Quarantine, now of the U. S. Forest Service, U. S. Department of Agriculture, have been studying all phases of the biology and control of forest insects. An extensive collection of gall midges, together with associated biological data, has accumuluated during this investigation and has recently been made available to me. The present paper provides names and descriptions for a number of species occurring in cones and seeds of western conifers; their biological characteristics will be published in a forthcoming manual of the insects associated with these trees in western United States.

Throughout the work I have omitted morphological descriptions of immature stages. Almost without exception, larvae in this collection were so poorly mounted that detailed examination under a compound microscope was not possible. Even in those few cases in which most larval characters were visible, I have preferred to postpone publication of descriptions until concepts of species differences in the larval stage have been clarified. Associations of larva and adults have been made largely on the basis of the available biological information, aided in a few cases by incomplete morphological details.

I wish to thank F. P. Keen, California Forest and Range Experiment Station, for making this collection of gall midges available to me and for encouraging my efforts. I am also grateful to Dr. A. Earl Pritchard, University of California, for making preliminary identifications of a number of the species included herein.

Specimens deposited in the U. S. National Museum are indicated below by the initials USNM; those in the California Insect Survey at Berkeley by CIS.

Genus **Rübsaamenia** Kieffer

Rübsaamenia Kieffer, 1894, Ann. Soc. Ent. France **63:** 333 (type, *Asynapta pectoralis* Winnertz; by original designation); 1913, Gen. Ins., fasc. 152: 278; Felt, 1911, Journ. New York Ent. Soc. **19:** 40; 1916, New York State Mus. Bull. 180: 129; 1925, New York State Mus. Bull. **257:** 140.

To my knowledge no previous mention of the occurrence of this genus in North America has been made. The species assigned to it may be recognized by the presence of the base of vein Cu_1 (this vein obsolete basally in the closely related North American genus *Holoneurus*) and by the long slender recurved abdomen, which separates it from the North American genera *Asynapta* and *Clinorhytis*. *Rübsaamenia* runs to *Porricondyla* in Pritchard's (1953) key to California genera of Porricondylini; it may be separated from that genus by the recurved abdomen and by the fact that vein Cu_1 is present to the base of the wing. It is represented in the United States by the single species described below.

Rübsaamenia keeni, n. sp.

Fig. 1, a–g

Male.—Head as wide as high from anterior view, eye bridge about 12 facets wide. Scape of antenna subtriangular, length about 2.5 times width at apex; pedicel roughly rectangular, 0.7 as wide as apex of scape, not narrowed apically; flagellum with 12 to 24 segments, those of the smallest individuals with the fewest segments, segments decreasing in length from base to tip, apical segment 1.5 times as long as subapical and narrowed to a blunt point at apex; fifth flagellar segment (fig. 1*g*) 2.0 times as long as wide; stem with subapical expansion, equal in length to node, which is as wide as long, slightly narrower at base than at tip; circumfilum a simple, tightly fitting ring encircling node at proximal third. Palpus (Fig. 1*c*) of four segments, proportions 1:1.2:2.1:3 (average of type series); second segment widest, third and fourth successively narrower; setae longer than width of third. Wing (Fig. 1*b*) 2.3 times as long as wide; membrane with fine microtrichia; R_1 ending in costa at basal 0.4; R_s nearly parallel with costa; R_5 bending posteriorly to meet and terminate costa at or very slightly before wing tip; M_{3+4} visible from wing base to margin; Cu_2 terminating at middle of posterior margin of wing. Hind femur slightly longer than tibia; first tarsal segment with a short, blunt apicolateral projection on all legs; proportions of

hind tarsal segments 1:8.3:4.6:2.6:1.4 (average of type series); fore, mid, and hind claws (Fig. 1*d*) each with a long basal tooth; each pulvillus very slightly shorter, equal to, or slightly longer than claw. Terminalia (Fig. 1*a*) longer than wide (viewed dorsally); length of basistyle about 2.3 times its greatest width, with an inner apical lobe obscured in some mounts by the dististyle; inner surface of lobe covered by a patch of short, slender spines; dististyle 2.0 times as long as wide at base, bluntly rounded distally, with an even, dense row of blunt, stout spines along distal third or fourth of inner margin, this comb terminated by two heavy, blunt teeth at apex. Tenth sternite and tenth tergite bilobed, the former distinctly shorter than the latter and less deeply incised at center line; aedeagus truncate, with a shallow central notch and a small projection on distal margin midway between central incisure and lateral margin; proximally, aedeagus with a curved arm on each side connecting with the basistyle, and a slender median arm tapering to a sharp point, on each side of which there is connected an irregular, sac-shaped structure.

Female.—Head, eye bridge, scape, and pedicel as in male. Flagellum with 10 to 26 segments, the smallest individuals with the fewest segments; first flagellar segment longest, remaining segments decreasing in length from base to tip, apical segment somewhat elongated and narrowed to blunt apical point. Fifth flagellar segment (Fig. 1*f*) with node 1.3 times as long as wide; stem short, 0.25 as long as node; circumfilum a simple, tightly fitting ring as in male, encircling middle of node. Palpus of four segments, proportions 1:1.3:2.6:3.3 (average of type series), similar in general appearance to that of male. Wing and legs as in male. Terminal abdominal segment (Fig. 1*e*) with paired, elongate appendages, each about 2.5 to 3.0 times as long as wide; in addition, a flat, bilobed plate nearly covering basal half of each appendage and attached thereto, similar in shape to tenth sternite of male; a sclerotized internal spermatheca with paired lateral arms also present.

Holotype.—♂, Butte County, Calif, 29-IX to 7-X, 1953, Calif. Div. Forestry, reared from cones of *Abies magnifica*, Hopkins no. 32738e. U.S.N.M. no. 63027.

Paratypes.—7 ♂♂, 14 ♀♀, same data as holotype, Hopkins nos. 32737, 32737e and 32737h. 3 ♂♂, 3 ♀♀ (CIS); remainder (USNM).

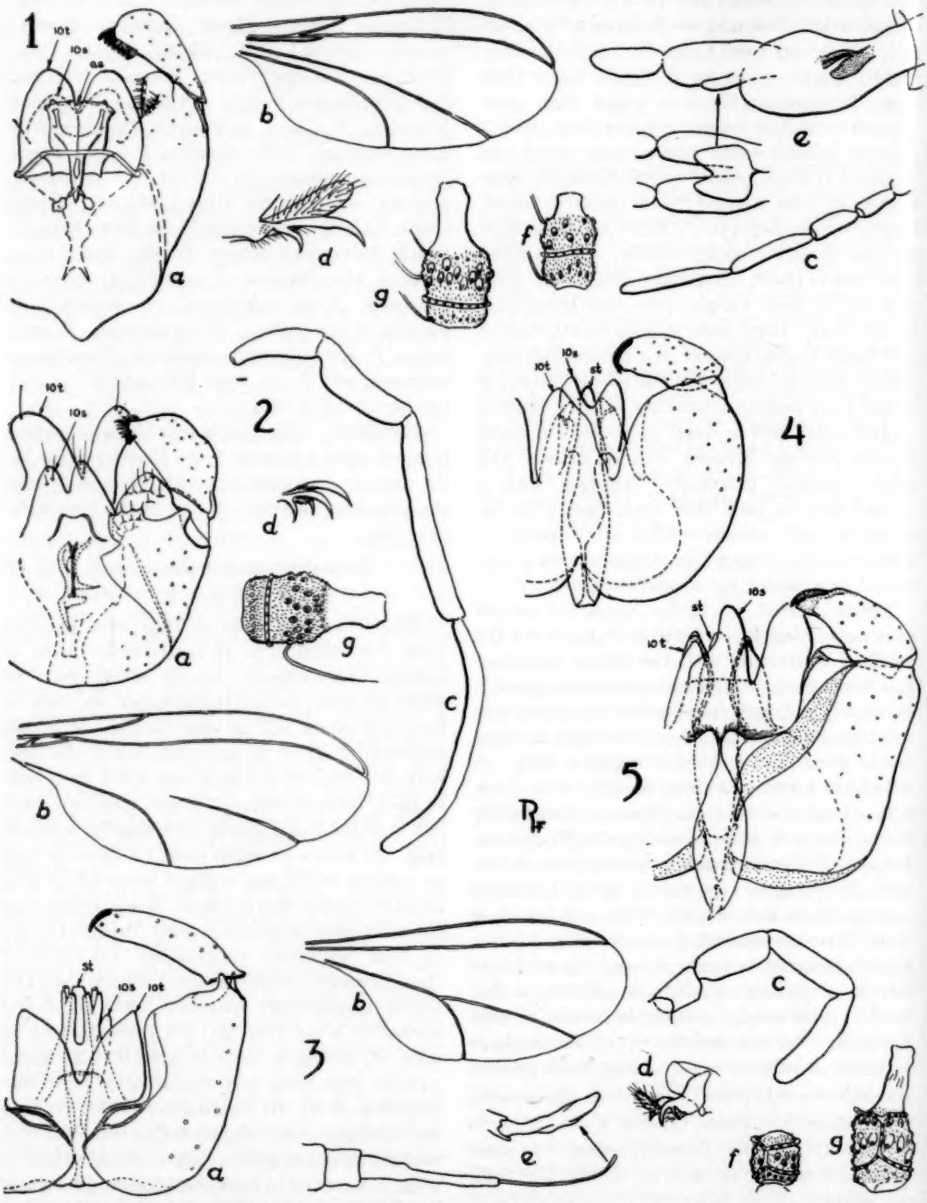
Additional material examined.—CALIFORNIA: 24 ♂♂, 44 ♀♀, 38 larvae; Crescent City, Gasquets, General Grant National Park, Kyburz, McKinney Creek, Mono National Forest, Sequoia National Park, Mount Shasta City, Six Rivers National Forest, Yosemite National Park. COLORADO: 2 ♀♀, 18 larvae; Cheyenne Mountain, N. Cheyenne Canyon, Manitou, Williams Canyon. NEW MEXICO: 3 ♂♂; Pecos Mountains. OREGON: 65 ♂♂, 61 ♀♀, 50 larvae; Ashland, near Lamb's Mine (Ashland), Clover Creek, Colestin, Jenny Creek, La Pine, Netart's Beach, Palmerlee's Ranch, Waldo. Taken from cones of *Abies concolor*, *A. grandis*, *A. magnifica shastensis*, *Picea englemanni*, *P. contorta* var. *latifolia*, *Pinus jeffreyi*, *P. lambertiana*, *P. ponderosa*, *P. ponderosa* var. *scopulorum*, *Pseudotsuga menziesii*, and *P.* sp. from February 17 to November 26, 1913–1954.

Discussion.—This species may be distinguished from all other members of the Porricondylini by the generic characters given above, and by the characteristic features of the male terminalia (Fig. 1*a*).

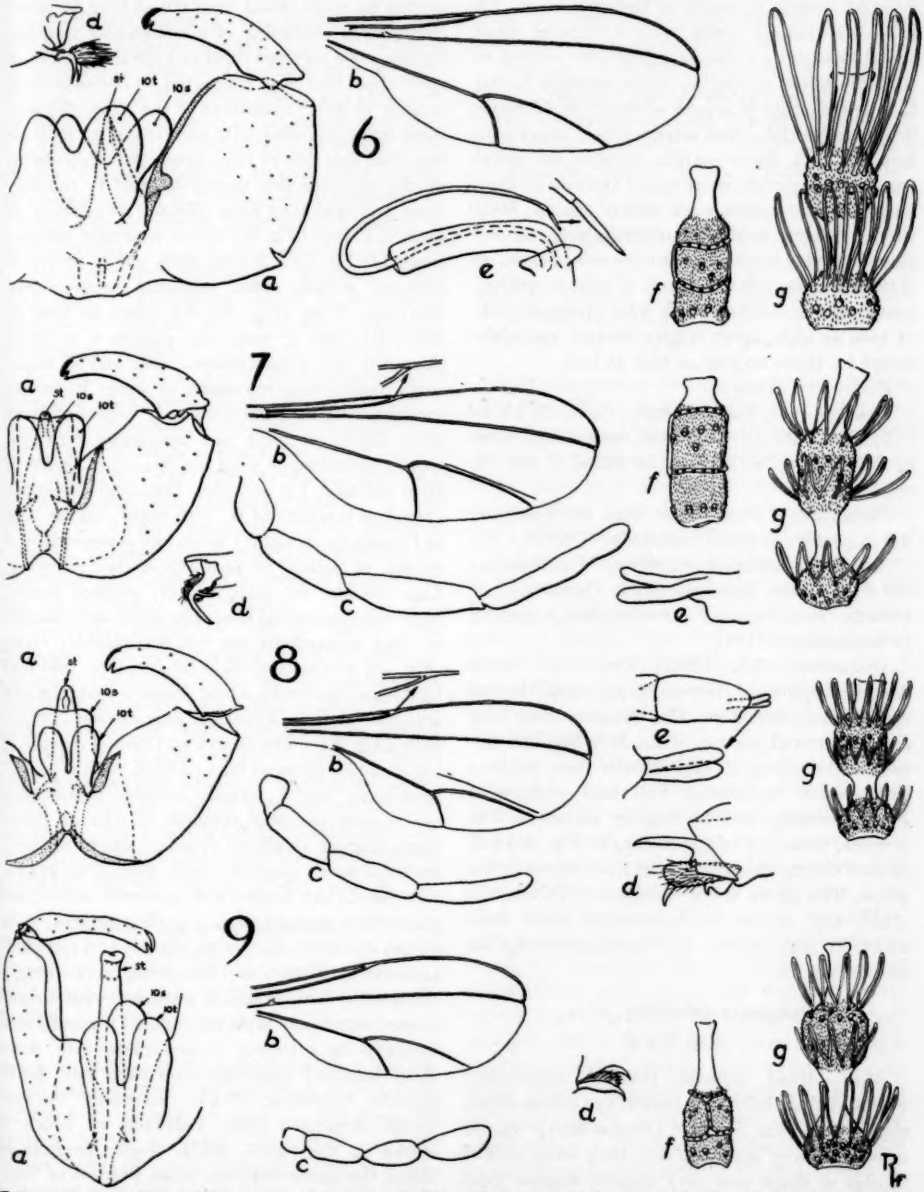
Holoneurus strobilophilus, n. sp.

Fig. 2, a–d, g

Male.—Head as wide as high from anterior view, eye bridge 8 to 10 facets wide. Scape of antenna subtriangular, length about equal to width at apex; pedicel subglobular, as wide as long and about 0.7 as wide as apex of scape; flagellum of 21 or 22 segments, which decrease only very slightly in length and width from base to apex; terminal segment longer than subterminal, with the apical nipple; fifth flagellar segment (Fig. 2*g*) with a proximal node 1.2 times as long as greatest width and a distal stem 0.7 as long as node; circumfilum a simple, closely fitting ring encircling node at proximal third. Palpus (Fig. 2*c*) of four segments, proportions 1:1.4:2.4:3.3 (holotype only), second segment widest, third and fourth progressively narrower, setae short and scattered. Wing (Fig. 2*b*) 2.3 times as long as wide, R_1 ending in costa at basal 0.4; R_s nearly parallel with costa and appearing to be a continuation of R_5; R_5 bending posteriorly to meet and terminate costa slightly before wing tip; M_{3+4} straight except at extreme apex, visible to base of wing; Cu_2 curved to meet posterior wing margin at basal 0.45 of wing. Hind femur slightly longer than tibia; proportions of hind tarsal segments 1:8.0:5.0:2.5:1.2 (one leg of holotype only); fore, mid and hind claws each with a long basal tooth; each pulvillus about 0.5 as long as claw. Terminalia (Fig. 2*a*) slightly longer than wide



FIGS. 1–5.—1, *Rubsaamenia keeni*, n. sp.; 2, *Holoneurus strobilophilus*, n. sp.; 3, *Dasyneura abiesemia*, n. sp.; 4, *Phytophaga carpoghaga*, Tripp, male terminalia; 5, *Janetiella siskiyou* Felt, male terminalia. (a, male terminalia; *b*, wing; *c*, male palpus; *d*, hind claw, male; *e*, terminal segments of female ovipositor; *f*, fifth flagellar segment, female; *g*, fifth flagellar segment, male. Abbreviations: 10t = tenth tergite; 10s = tenth tergite; ae = aedeagus; st = style.)



FIGS. 6–9.—6, *Contarinia oregonensis*, n. sp.; 7, *Mycodiplosis conicola*, n. sp.; 8, *Mycodiplosis coryloides*, n. sp.; 9, *Lestodiplosis taxiconis*, n. sp.; (*a*, male terminalia; *b*, wing; *c*, male palpus; *d*, hind claw, male; *e*, terminal segments of female ovipositor; *f*, fifth flagellar segment, female; *g*, fifth flagellar segment, male. Abbreviations: 10t = tenth tergite; 10s = tenth sternite; st = style.)

(viewed dorsally); length of basistyle about 2.0 times its greatest width, with a rounded inner apical lobe and a truncate apical lobe ventral to it, both lobes noticeably more densely haired than basistyle itself; length of dististyle 2.1 times its greatest width, outer margin with a heavy subterminal seta, inner margin straight, an apical comb of many even, short spines and two or three longer stouter spines more widely spaced; style short, slender, rodlike; an irregularly shaped structure lying beneath and to one side of style, as if turned on its side as a result of slide mounting; tenth sternite bilobed, each lobe about as wide at base as high; tenth tergite bilobed, each lobe about 1.5 times as long as wide at base.

Female.—Unknown.

Holotype.—♂, Butte County, Calif., 29-IX to 7-X, 1953, Calif. Div. Forestry, reared from cones of *Abies magnifica*, Hopkins no. 32737. U.S.N.M. no. 63028.

Paratypes.—4 ♂♂, same data as holotype. 2 ♂♂ paratypes (CIS), remainder (USNM).

Additional material examined.—CALIFORNIA: 6 ♂♂, Sequoia National Park. OREGON: 1 ♂, Colestin. From cones of *Abies concolor*, August 22 to September 24, 1914.

Discussion.—Felt (1915) keys the North American species of *Holoneurus* principally by the use of color characters. The comparatively long distal narrowed portion of the fifth flagellar segment will separate *H. strobilophilus* from the only two species, *multinodus* Felt and *photophilus* Felt, possessing over 20 flagellar segments. The terminal armature of the dististyle (Fig. 2*a*) will further distinguish this species from others in the genus. The genus is not included in Pritchard's (1953) key; it runs to *Porricondyla* there, from which it may readily be distinguished by its simple vein Cu_2.

Dasyneura abiesemia, n. sp.

Fig. 3, a–g

Male.—Head suboval (viewed anteriorly), widest slightly below the center; eye bridge about eight facets wide. Scape of antenna nearly square in outline, very slightly longer than wide; pedicel similar in shape and very slightly smaller than scape; flagellum of undetermined number of segments, some of the distal ones lost, but those that are present not decreasing noticeably in length or width from base to apex of flagellum; first two flagellar segments completely fused; fifth flagellar segment (Fig. 3*g*) with proximal node 1.2 times as long as wide; distal stem 0.9 as long as node; circumfilum consisting of one irregular ring encircling node on basal third and another nearly at apex, these two rings connected on opposite sides of node by short extensions of the rings; the segment rather lopsided, with stem emerging more or less from one side of node apex, the circumfilum on the opposite side loosely applied to the segment and extending some distance away from its surface. Palpus (Fig. 3*c*) of four segments, proportions 1.0:1.5:1.9:2.2 (one palp only), proximal segment widest, other segments progressively narrower. Wing (Fig. 3*b*) 2.5 times as long as wide; R_1 close to costa and joining it at basal third, the entire area between costa and R_1 somewhat darker than remainder of wing; R_5 nearly straight, bending posteriorly only very slightly at outer fourth to meet and terminate costa distinctly proximad of wing tip, M_{3+4} not visible in slide mounts; Cu straight, branched distinctly apicad of juncture of R_1 with costa; Cu_1 as long as Cu, nearly straight; Cu_2 curved posteriorly and ending at middle of posterior margin of wing. Legs thickly set with narrow, pointed scales; hind tarsal segments shrunken in all slide mounts so that proportions are not measurable; claws (Fig. 3*d*) not bent at right angles; fore, mid and hind claws each with a long, narrow ventral tooth which is 1.5 to 1.75 times as long as claw. Terminalia (Fig. 3*a*) wider than long (viewed dorsally); basistyle 2.0 times as long as wide, with a prominent inner apical, broadly rounded prominence and a more proximal shoulder in which a darkened, ringlike structure appears; length of dististyle 4.0 times greatest width, narrowing gradually distally and tipped with a narrow, sclerotized plate which appears as spur in slide mounts; style widest at middle, narrowing slightly to a rounded-truncate tip distally and narrowing more strongly toward the base, which is provided with a foot-shaped expansion; style surrounded ventrally and laterally by a deeply incised plate with three short terminal appendages on each side; tenth sternite consisting of two extremely narrow, widely separated lobes, only one of which is shown in the figure; tenth tergite completely filling the space between inner borders of basistyle and about as long as these, the incision deeper than one-half the length of plate, each lobe gently, then more abruptly tapered on inner margin to a narrow, rounded point.

Female.—Head, eye bridge, scape, pedicel and first two flagellar segments as in male. Flagellum

of 14 segments, the second segment the longest, the more distal segments becoming slightly narrower; fifth flagellar segment (Fig. 3*f*) 1.4 times as long as wide, with inconspicuous stem, circumfilum as in male. Wing, legs, claws, and pulvilli as in male, proportions of hind tarsal segments 1.0:8.0:4.2:2.4:1.3 (average of type series). Ovipositor (Fig. 3*e*) retractile, at least twice as long as abdomen when fully extended, terminated by a single lobe of variable shape about 6.0 times as long as wide.

Holotype.—♂, Palmerlee's Ranch, Oreg., 8-IX-1915, P. D. Sergent and J. E. Patterson, bred from cones of *Abies magnifica shastensis*, Hopkins no. 14200c. U.S.N.M. no. 63029.

Paratypes.—3♂♂, 4♀♀, same data as holotype. One ♂, 2♀♀ (CIS), remainder (USNM).

Additional material examined.—CALIFORNIA: 5♂, 3♀, 56 larvae; Butte County, Crescent City, General Grant National Park, McKinney Creek, Sequoia National Park. OREGON: 3♂♂, 11♀♀, 7 larvae; Applegate River, Ashland, Colestin. Taken from cones of *Abies concolor*, *A. grandis*, *A. magnifica*, and *A. magnifica shastensis*, July 18 to October 7, 1914–1953.

Discussion.—Pritchard (1953) states that three species of *Dasyneura* occur in California; *D. abiesemia*, the fourth, is the only one forming gall pockets in seeds and cone scales of *Abies* in California forests. In Felt's (1915) key to United States species, it falls within the series having a nearly straight vein R_5 and 14 flagellar segments; within this group it is the only species in which the female has a nearly sessile, subglobular fifth flagellar segment, and in which the proportions of the palpal segments are as shown in Fig. 3*c*.

Phytophaga carpophaga Tripp

Fig. 4

Phytophaga carpophaga Tripp, 1955, Can. Ent. **87**: 261.

A comparison of males collected as shown in the "Material examined" section below with a male paratype of *carpophaga* sent to the National Museum by the Canadian Department of Agriculture leaves no doubt that *carpophaga* is represented on the west coast. Most of Tripp's material is from Ontario and was collected from white spruce, *Picea glauca*.

I am including an illustration (Fig. 4) of the male terminalia of this species drawn from a Colorado specimen, since Tripp's photograph omits certain details which may eventually become important for the separation of *carpophaga* from other members of the genus.

Material examined.—CALIFORNIA: 9♂♂, 2♀♀, Crescent City. COLORADO: 7♂♂, 2♀♀, 3 larvae, Glenwood Springs, Manitou, Mountain View. Taken from cones of *Picea englemanni* and *P. sitchensis*, August 17 to October 25, 1913–1916.

Janetiella siskiyou Felt

Fig. 5

Janetiella siskiyou Felt, 1917, Journ. New York Ent. Soc. **25**: 194; Pritchard, 1953, Bull. California Ins. Survey **2**(2): 139.

Felt originally described larvae and females from the Siskiyou National Forest in California; his description of the females is based primarily on color characters, but since this midge appears to be quite host-specific for seeds of *Chaemocyparis*, there appears to be no need to repeat Felt's information or to add to it here.

A description of the terminalia is given below. Unfortunately, the single male available to me had been hardened in alcohol for such a long period of time that the regular mounting method obscured much of the detail; remaining parts of this specimen were nearly destroyed in the mount. No recently collected material was available for this study.

Male.—Terminalia (Fig. 5) stout, slightly longer than wide (dorsal view). Basistyle with overall width equal to overall length, entire proximal margin and almost entire inner margin with broad sclerotized bands, a lobe at inner apex with a band of sclerotization at its own inner edge, and a narrowly pointed lobe attached to inner margin at widest portion of basistyle; length of dististyle about 2.1 times greatest width, both inner and outer margins gently curved from base to join each other at apex, here provided with a single sharp, stout tooth; style bluntly rounded distally and proximally, its center portion obscured in the mount, proximal portion with a subtriangular plate ending proximally in a broadened expansion resembling an arrow-head; tenth sternite bilobed, a deep incisure separating the broadly pointed lobes; tenth tergite with two medially expanded lobes which are lightly sclerotized on their inner margins and separated by a cleft, the bottom of which is not visible in the mount.

Material examined.—Oregon: 4♀♀, 1♂;

Siskiyou National Forest, Waldo. Taken from cones of *Chaemocyparis lawsoniana* March 28, 1919, and August 15, 1914.

Contarinia oregonensis, n. sp.

Fig. 6, a, b, d, e, f, g

Male.—Head 1.2 times as high as wide from anterior view; eye bridge 12 to 14 facets wide. Scape of antenna subtriangular, length equal to distal width; pedicel subglobular, length equal to greatest width, 0.6 to 0.7 as wide as apex of scape; flagellum of 12 segments, the first two fused, their point of junction indicated by a narrow hyaline area, remaining segments approximately equal in size, terminal segment with distal stem reduced to a short nipple; fifth flagellar segment (Fig. 6*g*) with two nodes, the proximal one 0.8 as long as the distal; length of proximal stem 1.1 times proximal node; length of distal stem equal to that of distal node; two series of circumfila, one on each node, the loops of that on proximal node attaining middle of distal node, those of distal node attaining middle of proximal node of succeeding segment. Palpus of four segments, proportions 1.0:1.5:2.5:2.8 (holotype only), the second segment widest, third and fourth successively narrower; with sparse, scattered setae longer than width of second segment. Wing (Fig. 6*b*) 2.5 times as long as wide; R_1 entering costa at basal 0.4; R_5 curving posteriorly at distal third to meet and terminate costa only very slightly before wing tip, with a cross vein at basal 0.12 extending halfway to R_1 and ending midway between the two veins; Cu straight; Cu_1 gently curved throughout its entire length; Cu_2 terminating in posterior border of wing just apicad of point of origin. Legs long; hind femur 1.1 times as long as tibia; proportions of hind tarsal segments not recognizable because of damage to specimens; fore, mid, and hind claws (Fig. 6*d*) simple, each shorter than the pulvillus. Terminalia (Fig. 6*a*) wider than long (viewed dorsally); length of basistyle 1.4 times its greatest width[1] with a dark, thickened sclerotized area at center of inner margin, no inner lobe present; length of dististyle 3.5 times its greatest width, with an inner, subterminal notch. Style 3.5 times as long as wide, bluntly pointed apically, with two ill-defined membranes nearly attaining tip of style and lying in a different position in each mount; tenth tergite bilobed, width of each lobe at base about equal to length; tenth sternite bilobed, with central incisure slightly deeper than that of tenth tergite, length of each lobe about 1.2 times proximal width; style and tergites terminating at approximately the same level.

Female.—Head, eye bridge, scape, pedicel and palpus similar to those of male. Flagellum of 12 subequal segments; first two segments fused, with a narrow hyaline area in some specimens indicating the juncture; fifth flagellar segment (Fig. 6*f*) with proximal node 2.0 times as long as wide; distal stem 0.5 as long as node; two irregular circumfila encircling node and connected at opposite sides of node as shown. Wing and legs as in male. Ovipositor (Fig. 6*e*) retractile, about 0.6 as long as abdomen, terminating in a lightly sclerotized lobe which is the side view of the scissorslike terminus of ovipositors usually found in this genus.

Holotype.—♂, Mistletoe, Oreg., 25-VIII-1916, P. D. Sergent and J. E. Patterson, reared from cones of *Pseudotsuga menziesii*, Hopkins no. 14280e. U.S.N.M. no. 63030.

Paratypes.—8 ♂♂, 10 ♀♀, same data as holotype. Three ♂♂, 5 ♀♀ paratypes (CIS), remainder (USNM).

Additional material examined.—4 ♂♂, 4 ♀♀, same data as holotype. (USNM). These badly damaged specimens have little value for comparative purposes.

Discussion.—Felt (1917) employs the color of live specimens and antennal characters for the separation of males but does not attempt to key females. This is the only species of *Contarinia* known to occur in the Western United States, and the only United States species associated with conifers. Antennal and palpal characters of *Contarinia oregonensis* closely resemble those of *C. perfoliata* Felt and *C. agrimoniae* Felt; characters of the male terminalia (Fig. 6*a*) will distinguish *oregonensis* from the other two. The genus, although previously recorded from California, will run in Pritchard's (1953) key to *Thecodiplosis*, but may be distinguished by the invagination of the wing margin at the termination of vein R_5.

Mycodiplosis conicola, n. sp.

Fig. 7, a–g

Male.—Head suboval from anterior view, widest slightly below center; eye bridge 8 to 10 facets wide. Scape of antenna subtriangular, length equal to greatest width; pedicel subglobular, as long as wide, the same width as scape;

[1] In flattened-out holotype; other males in type series have shriveled basistyles.

flagellum of 12 segments, the first two completely fused with only a narrow subhyaline area indicating the junction, the remaining segments about the same length as the fifth but with narrower stems, twelfth segment with a long terminal nipple; fifth flagellar segment (Fig. 7*g*) with two nodes, the proximal one 1.1 times as wide as long, the distal one 1.7 times as long as wide and 1.7 times as long as proximal node; proximal stem equal in length to proximal node; distal stem 0.9 as long as distal node; three circumfila, the proximal on proximal node, its loops attaining basal half of proximal stem, middle at base of distal node, its loops attaining basal 0.6 of its node, the distal on distal portion of node, its loops attaining basal two-thirds of distal stem. Palpus (Fig. 7*c*) of four segments; proportions of segments 1.0:1.5:2.1:2.5 (one palp of holotype), first segment 1.5 times as long as wide, remaining segments successively narrower. Wing (Fig. 7*b*) 2.6 times as long as wide; R_1 ending in costa at basal 0.4; two sensory pores very close to the juncture as in figure; R_5 nearly straight but bent gently at distal fourth to meet and terminate costa at wing tip; M_{3+4} obsolete basally but visible to posterior margin of wing; Cu branching at level of junction of R_1 with costa; Cu_1 slightly curved, shorter than Cu; Cu_2 curved sharply at base and bent at nearly right angles to horizontal axis of wing. Each leg covered by very narrow scales which are longer and darker at ends of tibiae and tarsal segments 1 to 4; proportions of hind tarsal segments 1.0:6.5:4.0:3.0:1.8 (average of two legs on one paratype); four, mid, and hind claws (Fig. 7*d*) each bent sharply near base, nearly straight beyond, with a long delicate ventral tooth before the bend; each pulvillus 0.5 as long as claw. Terminalia (Fig. 7*a*) wider than long (viewed dorsally); basistyle stout, length 1.7 times greatest width; dististyle rather stout, length 3.0 times greatest width, basal third of outer margin bulging with a darker area as shown, apical third somewhat darkened and with a single tooth; style triangular, connected at base with inner surface of basistyle by a triangular extension, this continuous with a lateral footlike piece without a distinct termination in the mounts; style terminating proximally in two narrow extensions. Tenth sternite and tenth tergite about equal in length, both only very slightly shorter than style; tenth sternite truncate with rounded corners and very shallowly emarginate; tenth tergite deeply emarginate, the resulting lobes about 1.7 times as long as width at base.

Female.—Head, eye bridge, palpus, scape and pedicel as in male. Flagellum of 12 segments, the first two fused as in male, the distal segments becoming successively shorter with shorter stems, apical segment 2.0 times as long as wide, narrowing from distal half outward to rounded point; fifth flagellar segment (Fig. 7*f*) with proximal lobe 2.1 times as long as wide; distal stem 0.2 as long as proximal node; circumfila of two closely adhering rings, the basal encircling the node at basal 0.4, the distal at the extreme tip of node, the two rings connected on opposite sides of the segment. Wing and legs as in male. Ovipositor (Fig. 7*e*) about 1.5 times as long as abdomen, retractile, terminated by simple paired lobes.

Holotype.—♂, Butte County, Calif., 29-IX to 7-X, 1953, coll. Calif. Div. Forestry, reared from cones of *Abies magnifica*, Hopkins no. 32737. U.S.N.M. no. 63031.

Paratypes.—10♂♂, 29♀♀, same data as holotype. 5♂♂, 5♀♀ (CIS), remainder (USNM).

Additional material examined.—Oregon: 2♀♀; Ashland, Colestin. Reared from cones of *Abies concolor*, August 22 to October 23, 1914.

Discussion.—*Mycodiplosis conicola* is closely related by morphological characters to *M. alternata* Felt and *M. hudsoni* Felt, both of which have been recorded only from eastern United States, the former on *Podophyllum* and the latter on *Acer*. *M. conicola* and *M. coryloides* are the only species associated with the cones of western forest trees; *conicola* may be distinguished from *coryloides* by the shape of the proximal portion of the style and by the longer narrowed portions of the flagellar segments. See also discussion of *coryloides*, p. 56.

Mycodiplosis coryloides, n. sp.
Fig. 8, *a–e, g*

Male.—Shape of head from anterior view and width of eye bridge not visible in mounts available. Scape of antenna only very slightly longer than wide, widest slightly beyond the middle; pedicel subglobular, greatest width about 0.7 greatest width of scape; flagellum with terminal segments missing in all specimens, the segments not appreciably narrowed or shortened toward distal end of flagellum, first two flagellar segments

fused, without a trace of a division between; fifth flagellar segment (Fig. 8*g*) with two nodes, the proximal one 0.8 as long as greatest width, which is at about middle; proximal stem 0.4 as long as proximal node; distal node 1.1 times as long as wide and 1.4 times as long as proximal node; distal stem 0.6 as long as distal node; three circumfila, one on proximal node and two on distal, the proximal one with loops attaining basal half of proximal stem, middle one with loops attaining apical two-thirds of distal node, distal one with loops barely exceeding apex of distal stem. Palpus (Fig. 8*c*) of four segments, proportions 1.0:2.2:3.0:3.8 (average of type series), first segment about as long as wide, second widest, third and fourth successively narrower. Wing (Fig. 8*b*) 2.2 times as long as wide; R_1 ending in costa at basal 0.4 with a single sensory pore just before the junction; R_5 nearly straight, bending slightly at distal fourth to meet and terminate costa at wing tip or just beyond; M_{3+4} obsolete basally, visible only from branching of Cu to near posterior margin of wing; Cu straight, branching at about the level of R_1-costa junction; Cu_1 slightly curved, shorter than Cu; Cu_2 curved and ending in posterior margin slightly beyond point of origin. Leg scales so narrow as to be almost hairlike; hind femur slightly longer than tibia; proportions of hind tarsal segments 1.0:7.3:4.2:3.0:1.8 (average of type series); claw (Fig. 8*d*) on each leg bent sharply near the base, nearly straight beyond; fore, mid and hind claws each with an inconspicuous ventral basal tooth; pulvillus 0.6 as long as claw. Terminalia (Fig. 8*a*) wider than long (viewed dorsally); basistyle stout, length 2.0 times greatest width, with a diagonal strip of sclerotization at base; dististyle 0.6 as long as basistyle, length 4.0 times greatest width, curved and somewhat tapered to tip, with a distal tooth as in illustration; style stout, narrow at extreme base but widening rapidly on basal fourth or third, where it forms lateral triangular arms attaching to inner margin of basistyle, gradually narrowing on distal fourth to a blunt, rounded tip; tenth sternite rounded-truncate distally with the mere suggestion of a median invagination; tenth tergite bilobed, the incisure attaining the base of the lateral arms of the style, each lobe rounded apically.

Female.—Head, palpus, scape and pedicel as in male. Flagellum of 12 segments, the first two fused without any indication of a division, segments becoming slightly shorter toward apex of flagellum, the terminal segment 2.0 times as long as wide, narrowed to a point from distal half outward; fifth flagellar segment with proximal node 2.1 times as long as wide; distal stem 0.1 as long as node; two closely adhering circumfila in the form of irregular rings which are connected to each other at opposite sides of the segment. Wings and legs as in male. Ovipositor (Fig. 8*e*) fleshy, retractile, length not measurable in available specimens, terminated by simple paired lobes.

Holotype.—♂, Butte County, Calif., 29-IX to 7-X, 1953, Calif. Div. Forestry, reared from cones of *Abies concolor*, Hopkins no. 32738f. U.S.N.M. no. 63082.

Paratypes.—3♂♂, 5♀♀ same data as holotype. One ♂, 2♀♀ paratypes (CIS), remainder (USNM).

Additional material examined.—CALIFORNIA; 1♂, 2♀♀; Plumas National Forest (Quincy). OREGON: 1♂; Jenny Creek. From cones of *Abies magnifica* and *Pseudotsuga menziesii*, October to November 26, 1930–1938.

Discussion.—The two new *Mycodiplosis* species discussed here, *conicola* and *coryloides*, are very closely related and are the only species of the genus associated with cones of Western forest trees. *M. coryloides* may be distinguished from *conicola* by the narrower style and the more slender dististyle, and from *Mycodiplosis coryli* Felt, to which it is also closely related, by the longer claws and wider style flanges. Adults of several species of this genus have been reared from mycophagous larvae, but it is not known whether the mycophagous habit is common to the genus as a whole.

Lestodiplosis taxiconis, n. sp.

Fig. 9, *a–d, f, g*

Male.—Head nearly round from anterior view; eye bridge 9 to 10 facets wide. Scape of antenna 1.25 times as long as wide, slightly narrower at base than at apex; pedicel subglobular, slightly wider than long, rounded at apex; flagellum of unknown number of segments, the first two completely fused, appearing as a single segment with four nodes; remaining segments progressively shorter, apical segment narrowed and rounded at apex; fifth flagellar segment (Fig. 9*g*) with two nodes, the proximal 0.55 as long as wide and separated from distal node by a stem 1.5 times as long as proximal node; distal node as long as wide at greatest width, also somewhat

flask-shaped; distal stem equal in length to distal node; proximal node with a single circumfilum, loops of which nearly attain base of distal node; distal node with two circumfila, the proximal one very close to base of node and with loops nearly attaining greatest width of node; distal one situated very close to distal margin of node and with loops nearly attaining apex of distal stem. Palpus (Fig. 9*c*) of four segments proportions 1.0:2.6:2.6:3.1 (average of type series); first segment subsquare in outline, second and third slightly wider, fourth suboval and only very slightly wider than second and third. Wing (Fig. 9*b*) without markings, about two times as long as wide; R_1 ending in costa at basal 0.4; the suggestion of a crossvein, not distinctly connected with R_1, present near base of R_5; R_5 nearly straight for most of its length, meeting and terminating costa at wing tip; Cu straight, forked at outer 0.4; Cu_1 gently curved; Cu_2 likewise gently curved and terminating in posterior margin of wing just apicad of termination of R_1. Legs densely covered by very narrow scales; hind femur slightly longer than tibia; proportions of hind tarsal segments 1.0:5.6:2.4:1.3:1.0 (average of type series); fore, mid and hind claws (Fig. 9*d*) simple, not sharply curved; each pulvillus 0.8 as long as claw. Terminalia (Fig. 9*a*) longer than wide (viewed dorsally); basistyle slender, length nearly three times greatest width, with a distinct shoulder on inner dorsal margin at the middle; dististyle 0.5 as long as basistyle, 4.5 times as long as greatest width, swollen on basal fourth, remainder slender, slightly curved inwardly, only very slightly enlarged distally and with a distal slit; style nearly as long as basistyle, narrow proximally and expanding to its greatest width at proximal fourth where it is provided with inconspicuous lateral projections, thence gradually narrowing to tip which is very slightly expanded and truncate; tenth tergite bilobed, the bottom of the incision almost square, each lobe 1.5 times as long as wide and evenly rounded at tip; tenth sternite slightly shorter than tergite and considerably shorter than style, rounded at tip (not divided into lobes).

Female.—Head, eye bridge, palpus, scape, and pedicel as in male. Flagellar segments with single nodes, the first two completely fused; fifth flagellar segment with length of node 1.6 times the greatest width; distal stem 0.9 as long as node; circumfila not distinguishable in the poorly mounted specimen. Wing as in male. Hind tarsal segments missing; terminal abdominal segments fleshy; ovipositor not retractile.

Holotype.—♂, Colestin, Oreg., 30-VI-1914, J. E. Patterson, reared from cones of *Pseudotsuga taxifolia*, Hopkins no. 12535g. U.S.N.M. no. 63033.

Paratypes.—4 ♂♂, same data as holotype; 2 ♂♂ (CIS), remainder (USNM). Eleven ♂♂, 3 ♀♀, near Lamb's Mine, Ashland, Oreg., 17-II-1915, F. P. Keen and P. D. Sergent, reared from cones of *Pseudotsuga menziesii*, Hopkins no. 13209e-3 through e-8; 6 ♂♂, 1 ♀ (CIS) remainder (USNM).

Additional material examined.—1 ♂, 1 ♀, same data as Hopkins nos. 13209e-3 through e-8 (CIS). These specimens are badly damaged and have little value for comparative purposes.

Discussion.—Males of *Lestodiplosis taxiconis* may be distinguished at once from all other North American species of *Lestodiplosis* by the relatively short, narrowed portions (length 2.5 times width vs. length 3.5 times width) of the fifth flagellar segment, and by the fact that this species is associated with cones of Western forest trees.

Felt's (1921) key to the North American species of *Lestodiplosis*, based almost entirely on color and characters of the male antennae, is almost impossible to use for alcoholic or slide-mounted material. The genus needs extensive revision. Pritchard (1953) does not list the genus as occurring in California. In his key, *Lestodiplosis* runs to *Retinodiplosis* or to *Itonida*, from which it may be separated by the presence of a lobe on the inner surface of the basistyle (Fig. 9*a*).

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HERPETOLOGY.—*The herpetofauna of Harford County, Maryland.* CLYDE F. REED, Baltimore, Md. (Communicated by Doris M. Cochran.)

One of the most varied geographical areas in Maryland is Harford County. It is bounded on the east by Susquehanna River, on the southeast by Chesapeake Bay, and on the west and south by Little Gunpowder River. To the north there is no definite geographic boundary with Pennsylvania. The largest inland streams are Deer Creek, Broad Creek, Rock Run, and Bynum Run.

The lower southeast eighth of the county is below the Fall Line, thus providing coastal situations along lower Susquehanna River, Chesapeake Bay, and Bush River. The Little Gunpowder runs along the western and southern boundary of Harford County, separating it from Baltimore County. Many deep rocky ravines are exposed along its course, down to the Fall Line, where the river flattens out into a tidal river, like Bush River and the lower Susquehanna River. Deer Creek also exposes extensive rock formations in the northern and central portions of the county, especially near The Rocks, near Kalmia, and below Darlington, where Deer Creek enters the Susquehanna River just below Conowingo Dam. Most of the rock formations in Harford County are acidic in nature, there being a few calcareous regions in the southwest portion of the county. These areas afford a variety of habitats for amphibians and reptiles, thus accounting for the large number of species found in the county.

Some of the areas in Harford County have been quite extensively studied. The most frequented area is the Broad Creek area where there is a Boy Scout Camp. Other areas well studied are the regions of The Rocks, Conowingo, Lapidum along the Susquehanna from Conowingo to Havre de Grace along the rocky slopes, the region about Aberdeen, and the regions about Bel Air, Churchville, Kalmia, Webster, Hickory, Fallston, Whiteford, Jarrettsville, Shawsville, Norrisville, Edgewood, and Magnolia.

The distribution of the species of plants and animals to be found in Harford County follows the geographical boundaries very closely. Species that are typically of Piedmont distribution are: *Diadophis punctatus edwardsii*, *Lampropeltis triangulum triangulum*, *Natrix septemvittata*, *Clemmys insculpta*, and *Clemmys muhlenbergii*; species that are typically coastal reaching up into Harford County are: *Eumeces fasciatus*, *Eumeces laticeps* (?), *Carphophis amoena amoena*, *Opheodrys aestivus*, *Lampropeltis getulus getulus*, *Storeria dekayi*, and *Sternotherus odoratus*; the other species are found in both regions.

Many of the following records are additions or new records to the herpetofauna of Harford County. Since several of these records are additions to McCauley's *The reptiles of Maryland*, 1945, the following annotated list of species is presented. All records and annotated specimens have been collected by the author unless otherwise noted. The collection numbers refer to specimens in the herpetological collections of the author. A total of 43 species are listed from Harford County, 18 of these species are either new records or extend the known range of the species in this county.

1. *Diemictylus viridescens viridescens* (Rafinesque): NEWT or RED EFT. The Rocks (in meadow pools, May 1954); Broad Creek (in swamp 2 miles north of Broad Creek Camp); Rock Run (in swamp and edge of stream, spring 1953); Churchville (eft stage).

2. *Desmognathus fuscus fuscus* (Green): DUSKY SALAMANDER. The Rocks, Rock Ridge Road (April 10, 1954, #789–791); Broad Creek (common under rocks along streams, May 12, 1953, #127); Lapidum (April 25, 1953, #129–130; April 9, 1953, #146–154); Shures Landing below Conowingo Dam (September 20, 1953, #18–24; March 20, 1954, #569–572); Susquehanna River at Schweers Landing (April 9, 1953, #186–192); Deer Creek near Darlington (April 9, 1953, #273); Kalmia (in a spring, May 1955).

3. *Plethodon cinereus cinereus* (Green): WOOD SALAMANDER; RED-BACK SALAMANDER (red and black phases). Broad Creek (common under rocks and logs); Deer Creek at Route 1, north of Bel Air (Oct. 15, 1954, #995–1007); Deer Creek near Darlington (September 20, 1953, #28–35, 85; April 19, 1954, #144; April 9, 1953, #267–272); along Rock Run near Susquehanna River at Schweers Landing (April 9, 1953, #166–185, 193–202); Lapidum (April 9, 1953, #647–650; April 25, 1953, #99–102); Deer Creek at Susquehanna River (April 25, 1953, #155–165; summer 1953,

#131–139); Shures Landing below Conowingo Dam (March 20, 1954, #524–527).

4. *Plethodon glutinosus glutinosus* (Green): SLIMY SALAMANDER. Deer Creek near Darlington under rocks on hillsides (April 9, 1953, #103–108; #274–275; September 20, 1953, #26; April 25, 1953, #114–125, including Deer Creek at Susquehanna River); Deer Creek at Route 1, north of Bel Air (October 15, 1954, #977–978); Broad Creek. Many of the specimens from the Deer Creek and Susquehanna River areas have no spots; they are solid black.

5. *Pseudotriton ruber ruber* (Sonnini): RED SALAMANDER. Rock Run near Schweers Landing (April 25, 1953, #112–113); Broad Creek (in old spring house near swamp; under logs); Dublin; Deer Creek near Darlington (April 19, 1953, #145); Shures Landing below Conowingo Dam; The Rocks (in spring house, April 1954); Edgewood; Churchville (in old well).

6. *Eurycea bislineata bislineata* (Green): TWO-LINED SALAMANDER. Broad Creek (May 12, 1953, #128, edge of streams); Shures Landing below Conowingo Dam (April 9, 1953, #126; September 20, 1953, #17); Susquehanna River near Schweers Landing (common); Rock Run.

7. *Eurycea longicauda longicauda* (Green): LONG-TAILED SALAMANDER. Shures Landing below Conowingo in seepage (September 20, 1953, #14–16); Broad Creek (in spring house).

8. *Bufo terrestris americanus* Holbrook: AMERICAN TOAD. Broad Creek; Bush River; Churchville; Havre de Grace (common in all localities); Lapidum.

9. *Bufo woodhousii fowleri* Hinckley: FOWLER'S TOAD. Churchville; Broad Creek; Lapidum.

10. *Acris gryllus crepitans* Baird: CRICKET FROG. Rock Run; Broad Creek; Churchville (frequent); along Susquehanna River in canal, Conowingo to Havre de Grace.

11. *Hyla crucifer crucifer* Wied: SPRING PEEPER. Havre de Grace; Churchville; Broad Creek; woods, 2 miles north of Havre de Grace (October 6, 1955, #1024).

12. *Hyla versicolor versicolor* LeConte: COMMON TREE FROG. Broad Creek.

13. *Rana catesbeiana* Shaw: BULL FROG. Bush River (in swamps); Havre de Grace; Aberdeen; Broad Creek (in swamps near camp); Hickory north of Bel Air.

14. *Rana clamitans* Latreille: GREEN FROG. Churchville (April 25, 1953, #501); Broad Creek; Bel Air; Hickory; Susquehanna River near Glen Cove (May 12, 1953, #284).

15. *Rana sylvatica* LeConte: WOOD FROG. Deer Creek at Darlington (September 20, 1953, #25); Shures Landing below Conowingo Dam (March 20, 1954, #567); Broad Creek (in nearby swampy areas); Deer Creek at Susquehanna River; Schweers Landing along Susquehanna River (October 6, 1955, #1025).

16. *Rana pipiens* Schreber: LEOPARD FROG. Churchville (April 25, 1953, #502–503); Broad Creek; Bel Air.

17. *Rana palustris* LeConte: PICKEREL FROG. Broad Creek; woods along Route 1 at Deer Creek (October 6, 1955, #1023); Lapidum (October 6, 1955, #1027).

18. *Chelydra serpentina serpentina* (Linnaeus): SNAPPING TURTLE. Havre de Grace; Webster; Edgewood; Deer Creek near Kalmia (April 30, 1955, #980); Broad Creek, in Broad Creek Lake (seen up to 30 pounds; many juveniles caught in streams leading to lake); The Rocks; Churchville (frequent in ponds and swamps).

19. *Clemmys guttata* (Schneider): SPOTTED TURTLE. Broad Creek (behind dam, in swamp next to creek, 5 collected); Bush River; Darlington; along Susquehanna River near Conowingo Dam.

20. *Clemmys muhlenbergi* (Schoepff): MUHLENBERG'S TURTLE. Broad Creek, in swampy area near pipe drain at Broad Creek Scout Camp (4 collected in three years). New to Harford County.

21. *Clemmys insculpta* (LeConte): WOOD TUTLE. Roberts Island; Broad Creek (below dam, 2 collected along creek); Havre de Grace (USNM 14582).

22. *Terrapene carolina carolina* (Linnaeus): BOX TURTLE. Havre de Grace; Webster; Aberdeen; Emmorton; Bel Air; The Rocks; Broad Creek; Rock Run.

23. *Sternotherus orodatus* Latreille: MUSK TURTLE. Along Little Gunpowder River, in Harford County, near Fork.

24. *Chrysemys picta picta* (Schneider): PAINTED TURTLE. Havre de Grace; along Susquehanna River near Darlington; Conowingo Dam; Broad Creek (around lake and in streams); Aberdeen; Churchville. New to Harford County.

25. *Graptemys geographica* (LeSueur): MAP TURTLE. Havre de Grace (USNM 17833); Susquehanna River at Darlington (Roger Conant).

26. *Kinosternon subrubrum subrubrum* (Lacépède): MUD TURTLE. Bush River (CMP 8035).

27. *Sceloporus undulatus hyacinthinus* (Green): NORTHERN FENCE SWIFT. The Rocks (RHM); Broad Creek (collected near nature lodge). Ex-

tending the range north and east in Harford County in Maryland.

28. *Eumeces fasciatus* (Linnaeus): FIVE-LINED SKINK. Bush River (CMP 8379); Broad Creek (seen near rocks where copperheads stay; collected by nature lodge). Extending range northward about 20 miles to Pennsylvania line.

29. *Natrix septemvittata* (Say): QUEEN SNAKE. Along Susquehanna River above Havre de Grace; near Edgewood; Broad Creek (frequent along streams on overhanging branches); Schweers Landing along Susquehanna River (ZSP 385); Van Bibber (USNM 36087). Extending range northward along Susquehanna River to Pennsylvania Line.

30. *Natrix sipedon sipedon* (Linnaeus): COMMON WATER SNAKE. The Rocks, along Deer Creek; Havre de Grace; Dublin; Carsens Run; Churchville; Broad Creek (common along streams and on overhanging branches).

31. *Thamnophis sauritus sauritus* (Linnaeus): RIBBON SNAKE. Near Aberdeen; Broad Creek (some observed with part of tail missing); The Rocks (2 specimens observed and let go, July 1954); Bush River (CMP 8374); Edgewood Arsenal (MNHS); The Rocks (RHM). Extending range north and east to Susquehanna River near Pennsylvania line.

32. *Thamnophis sirtalis sirtalis* (Linnaeus): GARTER SNAKE. Shures Landing below Conowingo Dam (March 20, 1954, #565); Broad Creek; Havre de Grace; The Rocks; Churchville. Extending range north and east to Pennsylvania line.

33. *Haldea valeriae valeriae* Baird and Girard: EASTERN GROUND SNAKE. Broad Creek (under old plant stalk, embedded in ground); Prospect; north of Bradshaw, along Little Gunpowder. New to Harford County.

34. *Heterodon platyrhinos platyrhinos* Latreille: HOG-NOSED SNAKE. Broad Creek (5 collected in year, near fence posts and in dead logs); near Magnolia (DOR, May 1952); Aberdeen (Robert Duppstatt). Extending range north and east to Pennsylvania line.

35. *Diadophis punctatus edwardsi* (Merrem): RING-NECKED SNAKE. Deer Creek at Susquehanna near Darlington (September 20, 1953, #27); Broad Creek (under rotted logs and flat rocks). New to Harford County.

36. *Storeria dekayi* (Holbrook): DEKAY'S SNAKE. Churchville. New to Harford County.

37. *Opheodrys aestivus* (Linnaeus): ROUGH GREEN SNAKE. Aberdeen (climbing over shrubs). New to Harford County.

38. *Carphophis amoenus amoenus* (Say): WORM SNAKE. Conowingo; Broad Creek. New to Harford County.

39. *Coluber constrictor constrictor* (Linnaeus): BLACK SNAKE, BLACK RACER. Broad Creek; Deer Creek at Susquehanna River (Spring 1953, in woods). New to Harford County.

40. *Elaphe obsoleta obsoleta* (Say): PILOT BLACK SNAKE. Broad Creek; Churchville; along Little Gunpowder River; Bel Air; The Rocks. New to Harford County.

41. *Lampropeltis doliata triangulum* (Lacépède): MILK SNAKE. Havre de Grace (USNM 9284); Broad Creek (collected in ruins of old building). Extending range northward to Pennsylvania line.

42. *Lampropeltis getulus getulus* (Linnaeus): EASTERN KING SNAKE. Along Little Gunpowder River, northwest of Fallston; near Aberdeen (Robert Duppstatt). Extending range well into Harford County.

43. *Ancistrodon contortrix mokeson* (Daudin): COPPERHEAD. The Rocks (on boulders sunning, 1946); Kalmia (1954); Broad Creek (on rocky ledges below dam; some killed at camp site above lake); Deer Creek (Fowler, 1925); near Darlington; on rocky ledges along Susquehanna River just above Havre de Grace. Widens the range in Harford County.

Although the following species of amphibians have not been collected in Harford County, to the best of my knowledge, they do occur just below the Conowingo Dam on the Cecil County side of the Susquehanna River. Since they all show aquatic or semi-aquatic tendencies, there is no reason why they might not be found in Harford County.

Ambystoma maculatus (Shaw): Low ground between the Octoraro River and Port Deposit, #38–41, March 18, 1953; just below Conowingo Dam, #48, September 20, 1953.

Ambystoma opacum (Gravenhorst): Under logs just below Conowingo Dam, #47, September 20, 1953; low woods between Octoraro River and Port Deposit, #37 and 37a, March 18, 1953.

Hemidactylium scutatum (Schlegel): Under logs just below Conowingo Dam, #46, September 20, 1953.

Cryptobranchus alleganiensis (Daudin): Collected in the Octoraro River many years ago; common farther north in the Susquehanna River and its tributaries in Pennsylvania.

ZOOLOGY.—*A new genus and two new species of amphipods from Dry Tortugas, Florida.* CLARENCE R. SHOEMAKER, U. S. National Museum.

While collecting in the shallow water around Loggerhead Key, Dry Tortugas, in 1926, I discovered some small amphipods living among the coral sand and rocks. These proved to be a new genus, herein named *Hoplopheonoides*.

A number of amphipods found clinging to the exterior of a large spider crab taken by Dr. Waldo L. Schmitt south of Tortugas in August 1931, have been found to be a new symbiotic species of *Stenothoe*.

Family AMPHILOCHIDAE

Hoplopheonoides, n. gen.

Antennae short, subequal in length, flagella much shorter than their peduncles, accessory flagellum absent. Eye rather small. Mandible, molar well developed, cutting edge well toothed, spine row of several spines, palp absent. Maxilla 1, inner plate narrow and rather long, outer plate with 9–11 spines, palp 1-jointed. Maxilla 2 both plates narrow, inner the shorter. Maxillipeds normal. Coxal plates 1 and 2 rudimentary, 3 and 4 very large. Gnathopods 1 and 2 subchelate. Peraeopods 1 and 2 slender; peraeopods 3 and 4, slender with second joint linear; peraeopod 5, slender with second joint slightly expanded. Metasome segments normal. Urosome segment 1 long, with a high dorsal crest or lamella; urosome segments 2 and 3 very short and not coalesced. Uropods normal. Telson horizontal and entire.

Hoplopheonoides obesa, n. sp.

Fig. 1

Male.—Head as long as the first two body segments combined. The specimens examined having been in alcohol for a considerable time, the eyes were distorted so that their correct outline could not be determined. Antenna 1, peduncle rather stout, the joints decreasing consecutively in length; flagellum, a little longer than the last peduncular joint, the first joint being as long as the succeeding four joints combined. Antenna 2 a little shorter than 1 and comparatively slender; fourth joint a little longer than the fifth; flagellum as long as the fifth peduncular joint and composed of one long joint and four short joints. Upper lip bilobed. Mandible without palp; molar well developed; cutting edge rather broad and well toothed; spine row of six or seven spines, as well as could be determined. Maxilla 1, inner plate narrow and rather long and apparently without setae; outer plate with nine or eleven spines; palp 1 jointed and bearing distal spines. Maxilla 2, both plates narrow and slightly curved, inner plate the shorter, and each bearing one apical seta. Maxilliped, inner plate longer than the outer and reaching forward nearly as far; outer plate reaching nearly to the end of the first joint of palp; second joint of palp short and widened distally; third joint with a narrow distal lobe reaching nearly to the middle of the fourth joint.

Gnathopods 1 and 2 slender. Gnathopod 1 shorter than 2; second joint not quite as long as the fifth and sixth combined; fifth joint with lower lobe produced forward beneath the sixth; sixth joint over twice as long as wide, palm transverse and rather deeply incised; seventh joint slender, curved, much longer than the palm and bearing minute spinules on inner margin. Gnathopod 2 second joint longer than the fifth and sixth combined; fifth joint a little longer than the sixth; sixth joint expanding slightly distally, palm transverse, concave, having a small tooth near the seventh joint, and defined by a tooth bearing two spines; seventh joint slender, strongly curved, extending a little beyond the palm and armed on the inner margin with five spinules and a small forward-pointing tooth. Peraeopods 1 and 2 slender, alike, and about equal in length. Peraeopods 3 and 4 alike, but 3 the shorter (Fig. 1*a*). Peraeopod 5 about as long as 3, second joint slightly expanded but not produced below. The fourth joint of all peraeopods slightly expanded and very little produced below. The seventh joint of all peraeopods slender and little curved.

Coxal plates 1 and 2 rudimentary and nearly hidden by the greatly expanded coxal plate 3. Coxal plate 4 greatly expanded and reaching back to the end of coxal plate 5.

The body of the animal viewed from above widens rather abruptly toward the fourth segment which is the widest and which bulges out laterally over the central coxal plates. The body then tapers off to the posterior end which is very narrow.

Metasome segments evenly rounding below and without angles. Urosome segment 1 about

three times longer than segments 2 and 3 combined, and expanded dorsally into a thin vertical crest or lamella which is produced behind over segments 2 and 3. Urosome segments 2 and 3 very short, and apparently not coalesced. Uropods decreasing in length consecutively, all biramous, the outer ramus being the shorter. The upper margins of all rami bearing very fine, closely set spinules. Telson entire, with lateral margins converging to a narrow apex, and reaching nearly to the end of the peduncle of uropod 3. Length 2.5 mm.

Female.—Those specimens which are believed to be females are like the males, and are of the same size.

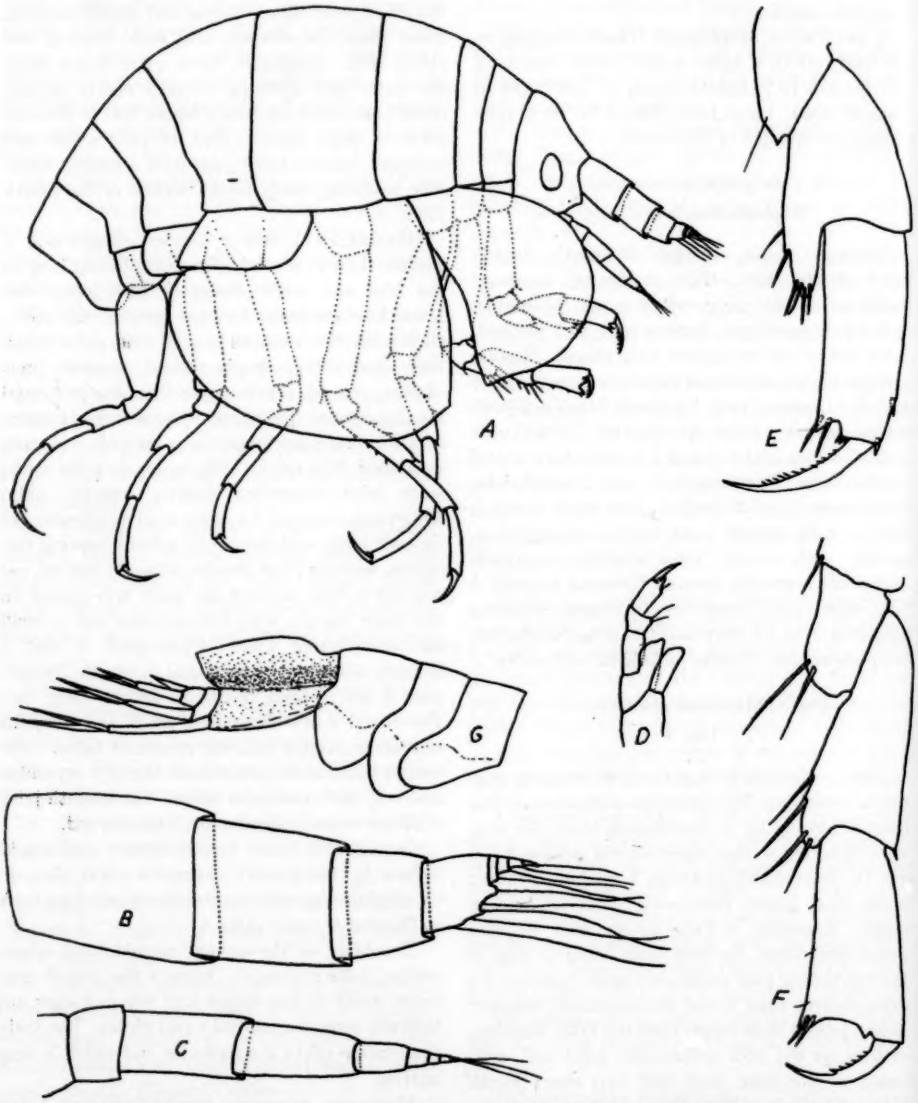

FIG. 1.—*Hoplopheonoides obesa*, n. gen. and n. sp., male: *a*, Front part of animal; *b*, antenna 1; *c*, antenna 2; *d*, left maxilliped; *e*, end of gnathopod 1; *f*, end of gnathopod 2; *g*, hind part of animal.

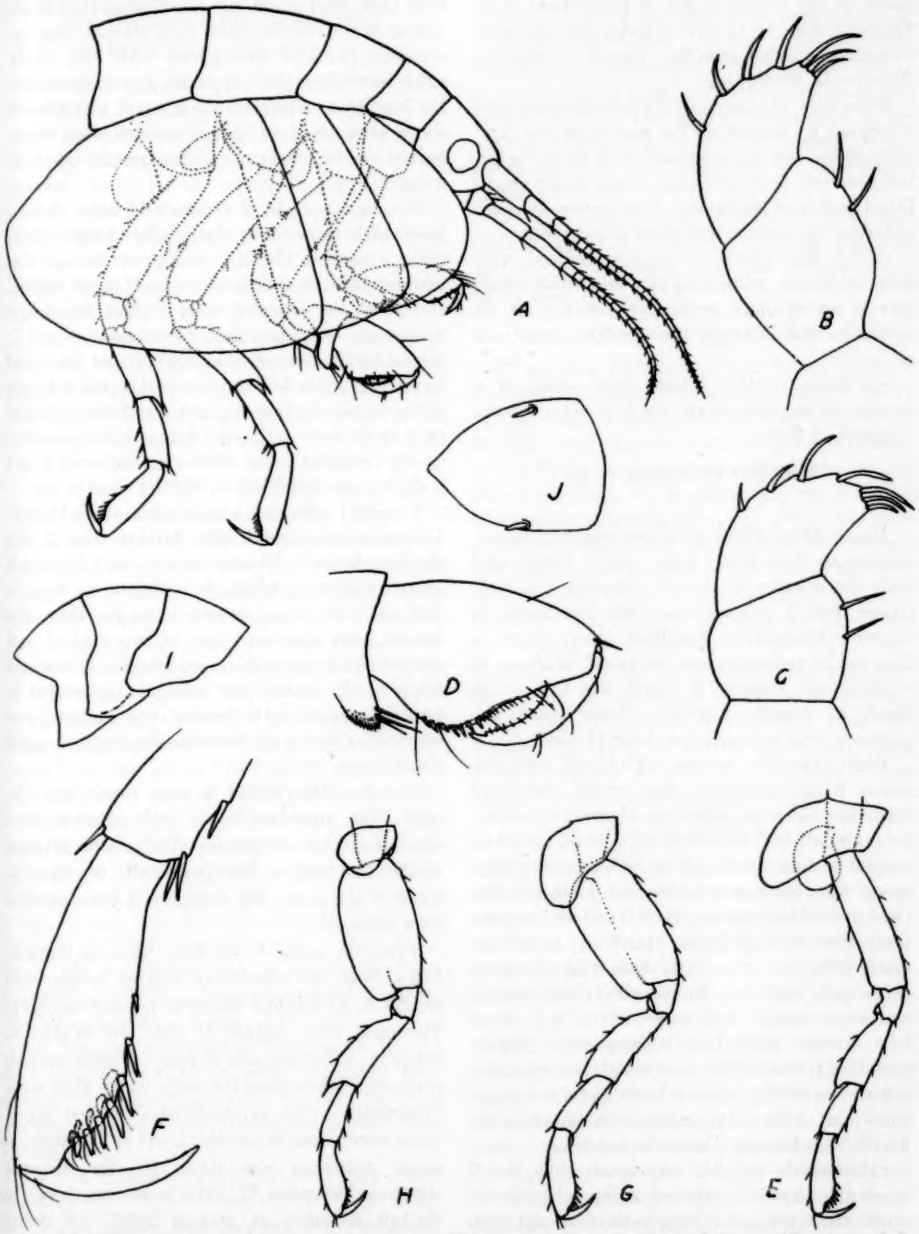

FIG. 2.—*Stenothoe symbiotica*, n. sp., male: *a*, Front part of animal; *b*, left maxilla 2; *c*, left maxilla 2 of another specimen; *d*, end of gnathopod 2; *e*, peraeopod 3; *f*, end of peraeopod 3 enlarged; *g*, peraeopod 4; *h*, peraeopod 5; *i*, metasome; *j*, telson.

Type.—A male, U. S. Nat. Mus. no. 96465, taken off the northern end of Loggerhead Key, Tortugas, Fla., in 15 feet of water, among sand, rocks, and marine growths, August 4, 1926, by Clarence R. Shoemaker.

Remarks.—This amphipod possesses characters belonging to several of the genera of the Amphilochidae, but the combination of these characters does not agree with that of any of the established genera of the family; it, therefore, appears necessary to create a new genus to receive it.

In life the animal is heavily mottled with greenish brown, yellowish green, and white, which give it an effective protective coloring for its native habitat amongst the coralline sands and rocks.

Specimens of this species were taken at a number of localities in the shallow water around Loggerhead Key.

Stenothoe symbiotica, n. sp.
Fig. 2

Male.—Head with lateral lobe angular, but not acutely so. Eye rather large, nearly round, and light straw color in alcohol. Antenna 1 a little longer than 2, penduncular joints decreasing in length consecutively; flagellum nearly twice as long as the peduncle, and composed of about 19 or 20 joints. Antenna 2, fourth and fifth joints equal in length; flagellum longer than the peduncle, and composed of about 16 joints.

Right mandible, cutting edge broad, with five coarse teeth; accessory plate broad with very finely toothed edge, spine row of about 12 spines; palp absent, but indicated by a small, pointed, conical protuberance. Left mandible, cutting edge broad with more and much finer teethn in tha right mandible; accessory plate broad with coarser teeth than in right plate. Maxilla 1, inner lobe small with one seta; outer lobe with six spine teeth; palp 2-jointed, the rounding distal margin and inner margin with spines. Maxilla 2, inner lobe absent; outer lobe bearing seven spines. Maxilliped, inner lobes very small, but separate; outer lobes entirely absent. Inner distal end of the third joint of the palp and the inner margin of the fourth joint bearing a brush of fine setae.

Gnathopods 1 and 2 very much alike, but 2 much the larger. Gnathopod 2, second joint not much expanded and as long as the fifth and sixth joints combined; fifth joint a little over half the length of the sixth, and with prominent lower lobe; sixth joint about one-third longer than wide, widest in the middle; palm very oblique, slightly concave, provided throughout with very short spinules, without defining angle, and merging into the joint by a broadly rounding curve which bears a row of seven stout spines; seventh joint stout, curved and bearing a row of fine spinules on inner margin.

Peraeopods 1 and 2 slender and alike, fourth joint little expanded; sixth joint longer than fifth, expanded distally, and provided on the oblique distal end with two rows of stout spines, thus, with the opposing seventh joint, forming a subchelate clasping organ. Peraeopods 4 and 5, second joint moderately expanded, and the third to seventh joints like those of peraeopod 3. Coxal plates 2 and 4 broadly expanded and much deeper than their body segments. Metasome segment 1 evenly rounding below. Metasome segments 2 and 3 slightly produced below, but not sharply so.

Uropod 1 extending a little farther back than 2. Uropod 3 extending a little farther than 2 and about as far as 1. All uropods with very few small spines. Uropod 3, peduncle not quite as long as first joint of ramus, which is longer than the second joint and bears one or two central and several distal spines on upper margin. Telson not reaching the end of the peduncle of uropod 3, lateral margins each bearing one spinule and converging to the narrow rounding apex. Length about 7 mm.

Female.—The female is very much like the male. The antennae are a little shorter. The coxal plates are not so deep. The gnathopods are smaller and weaker, but structurally the same as those of the male. The female is a little smaller than the male.

Type.—A male, U. S. Nat. Mus. no. 96464, taken from the exterior of a large spider crab caught in 50 fathoms south of Loggerhead Key, Tortugas, Fla., August 7, 1931, by Waldo L. Schmitt. A considerable number of these amphipods were taken from the crab, where they were apparently living symbiotically. Several specimens were taken in an otter trawl at Tortugas. A single specimen was taken by the steamer *Albatross* December 12, 1919, in an otter trawl, in 62–110 fathoms, at station 20037 off South Carolina.

NOTES AND NEWS

SIX DISTRICT AREA SCIENTISTS RECEIVE ACADEMY AWARDS

The Board of Managers of the Washington Academy of Sciences announce the 1955 winners of the awards given annually to scientists under 40 years of age in recognition of distinguished scientific achievements in the Biological, Engineering, and Physical Sciences, and to a secondary-school teacher for excellency in Teaching of Science. The selections were made by a committee of 25 leading scientists in the various fields represented.

The President of the Academy, Dr. MARGARET PITTMAN, of the National Institutes of Health, presented the awards at the Annual Dinner Meeting of the Academy, held on January 19, 1956, at the Kennedy-Warren.

BIOLOGICAL SCIENCES

Dr. CLIFFORD EVANS and Dr. BETTY J. MEGGERS, of the Smithsonian Institution, a husband-wife team, were selected to receive jointly an award in the Biological Sciences in recognition of their outstanding contributions to the prehistory and human ecology of Lowland South America. They were pioneers in archeology in the Amazon area. They lived and worked in the rain forests where no one previously had been willing to work, and there uncovered evidence that has necessitated drastic revision of previously held views of native culture in northeastern South America. Their field work has been in Peru, Lower Amazon, British Guiana among the Wai Wai Indians, and in coastal Ecuador.

Dr. Evans was born in Dallas, Tex., and received his Ph.D. from Columbia University in 1950. He joined the staff of the Smithsonian Institution in 1951 as associate curator, Division of Archeology, U. S. National Museum.

Dr. Meggers was born in Washington, D. C., and received her Ph.D. from Columbia University in 1952. Since 1954 she has been an honorary research associate at the Smithsonian Institution.

Lt. Col. ROBERT TRAUB, formerly chief of the Department of Entomology of the Walter Reed Army Institute of Research and now commanding officer of the U. S. Army Medical Research Unit in Malaya, was selected for a Biological Science Award in recognition of his outstanding work on ectoparasites, fleas and mites. He made outstanding contributions during World War II to the control of mite-borne scrub typhus in the Malaya area and during the Korean War to the control of hemorrhagic fever. Hemorrhagic fever, the greatest scourge of that area, is now almost a medical curiosity.

Dr. Traub was born in New York, N. Y., and received his Ph.D. from the University of Illinois in 1947. He has been with the United States Army since 1943.

ENGINEERING SCIENCES

E. ARTHUR BONNEY, of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md., was selected for the Engineering Science Award for his outstanding contributions in the field of supersonic aerodynamics. He has played a leading role in elucidating the problems of interactions among the wings, body, and tails of a supersonic missile. Specifically, his analysis and wind-tunnel tests have led to a fairly complete understanding of the aerodynamic and aeroelastic effects of a structure in regions of flow ranging from subsonic to high Mach numbers. His work has fundamental application in the design of air-borne missiles and rockets.

Mr. Bonney was born in Waltham, Mass. He received his master of science degree from New York University in 1942. He has been at the Applied Physics Laboratory since 1945.

PHYSICAL SCIENCES

Dr. TERRELL LESLIE HILL, of the Naval Medical Research Institute, Bethesda, Md., was selected for the Physical Science Award in recognition of his outstanding contributions to physical and biological chemistry. He has made significant advancements in the statistical mechanics of the behavior of assemblies of particles, molecules, and atoms and in the applications of statistical mechanics to problems of general chemistry, for example; the behavior of molecules at interfaces (gas bubbles in liquids, gases adsorbed on charcoal, etc.). His study of electrical properties of molecules has contributed to the understanding of the chemical behavior of cells, one example of which is muscle contraction.

Dr. Hill received his Ph.D. from the University of California in 1942. He has been on the

staff of the Naval Medical Research Institute since 1948.

TEACHING OF SCIENCE

HELEN NALE COOPER (Mrs. C. L.), of Bethesda, Md., was selected for the Teaching of Science Award for her distinction in fostering ability and enriching the perspective in mathematics. She has been an effective teacher for a number of years. Mathematics is presented so skillfully that even the slower learners are not scared away from mathematics while the faster learners are challenged to do extra work. Her students have won science fair prizes. She has helped many students decide on an engineering or mathematical career by constantly stressing the need for mathematicians and engineers. She is also active in teacher association projects.

Mrs. Cooper received her A.B. from West Virginia University. She has taught in the Montgomery County Schools since 1946 and in North Bethesda Junior High School since September 1955.

NEW DIRECTOR OF NAVAL RESEARCH

Dr. OSCAR THEODORE MARZKE, associate director of research for materials at the Naval Research Laboratory, has been appointed director of research at NRL. He succeeds Dr. EDWARD O. HULBURT, who has retired from Civil Service to become the senior scientist for the United States National Committee for the International Geophysical Year of the National Academy of Sciences.

A native of Lansing, Mich., Dr. Marzke received his B.Sc. degree in 1929 from Michigan State College and his Sc.D. degree in Metallurgy in 1932 from the Massachusetts Institute of Technology; he was a Swett scholar. During part of the time he was taking his postgraduate work he served at NRL as a laboratory technician.

From 1933 to 1946, Dr. Marzke was a metallurgist with the American Steel and Wire Co., doing both research and plant metallurgical work, his last position with the company being that of works metallurgist at the Waukegan, Ill., plant beginning in 1942. He joined the Naval Research Laboratory in 1946 as superintendent of the Metallurgy Division and became the first associate director of research for materials in 1954. During the period 1951–53, he was also head of the Metallurgy Branch of the Office of Naval Research and was Development Coordinator for ONR from January to August 1955.

Dr. Marzke is a member of the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the American Welding Society, Tau Beta Pi, the Research Society of America, the British Institute of Metals, the British Iron and Steel Institute, and the **Washington Academy of Sciences.**

ELECTRON TUBE INFORMATION SERVICE

The National Bureau of Standards has established a tube information service for accumulating and disseminating technical data on both domestic and foreign radio tubes. At the present time nearly 10,000 cards, filed by tube type number, are appropriately referenced to manufacturers' source material. In addition, about 10 percent of these cards, selected mainly from the high-use miniature and subminiature types, have been coded on punched cards for mechanical sorting.

With this unique service, it is possible to find (1) information about any particular tube, (2) all tube types whose electrical characteristics, bulb sizes, or base configurations fall within particular ranges, and (3) domestic tubes that can be substituted for unavailable foreign tubes. Recently, junction diodes and transistors have been added to the Bureau's program. The program began about seven years ago as a service to NBS personnel. It has since been extended to all scientists and engineers in Government and industry who have legitimate requests. This continuing service is being carried out by C. P. Marsden and J. M. Moffitt of the Bureau's electron tube laboratory.

The NBS tube information service was established to meet the ever-increasing number of requests for information that was not readily available on little-known tubes or tubes of foreign manufacture. As the service grew, it included more and more detailed information on larger numbers of tubes. Recently the Bureau has begun punched-card coding for automatic selection in order to process requests more rapidly. The goals of the service are to include the latest technical data on all domestic and foreign tube types and to have all such information coded.

The service includes all such data on electron tubes and semiconductor devices as electrical

characteristics, bulb size and base configurations, ambient operating conditions, and where possible, construction details. The main source of this information is the manufacturer's brochure or handbook. While the major companies automatically furnish the information through their distribution lists, numerous new and small companies must be queried directly whenever preliminary information on their products is gathered from advertisements, articles, and brochures. Special attention to these scattered sources has been required to maintain current the file on crystal diodes and transistors. The NBS files include products of about 80 domestic and 15 foreign manufacturers. In general, foreign data have been limited to Western European sources.

So far the Bureau has received requests for tube information mainly from other Government agencies, the military services, foreign governments, and local private industries. Most of the inquiries have been for information about the electrical characteristics of a particular tube type or the selection of a domestic tube for replacement in foreign equipment. Although this sort of request is easily met, questions on cathode operating temperature or contact potentials must be answered in general terms because these quantities vary with the manufacturer. Queries on tube types with specified electrical, mechanical, or geometric characteristics are usually answered by a combination of machine card sorting and reference research. Clearly, only general information can be coded on punched cards; after machine selection of several tubes that meet the specifications of the inquiry, reference research is required to supply the more specific information. In general, coding is on the basis of operating voltages, transconductance, etc.; and the tube types machine-selected are those within the ranges specified by the inquiry.

While the coding on punched cards has been completed only for the miniature and subminiature tubes with bulb sizes up to T6½, the Bureau plans to proceed as rapidly as possible with the coding of all other tube types. The semiconductor devices are being coded as soon as the information becomes available.

The Bureau's service is open to all who have legitimate requests. Inquiries may be made by telephone if desired. However, they should contain as much factual information as possible to expedite the reference research and should include background information where appropriate. The service cannot undertake to answer queries on tube applications in circuits; complex or highly detailed questions that may require laboratory research can be answered only on the basis of data available. Address inquiries to C. P. Marsden, chief, Electron Tubes Section, National Bureau of Standards, Washington 25, D. C.

DR. CURTIS CELEBRATES 80TH BIRTHDAY

Dr. HARVEY L. CURTIS, one-time member of the staff of the National Bureau of Standards and still an active physicist, was honored by his junior NBS colleagues on the occasion of his 80th birthday on December 14.

Dr. Curtis, who is internationally known for his work in absolute electrical measurements, was presented with a bound volume of letters from many of his former scientific associates congratulating him on his birthday.

Until his retirement in 1946, Dr. Curtis was chief of the Bureau's Inductance and Capacitance Section, a part of the Electricity Division. In this capacity Dr. Curtis supervised the maintenance and continued development of the national standards of reference for determining the two basic electrical quantities, inductance and capacitance. His work on the measurement of current and resistance in absolute units brought him into contact with renowned scientists in other national laboratories and made him an appropriate NBS representative at the International Electrical Congress at Paris in 1932.

In addition to the basic work on absolute electrical measurements, he inaugurated fundamental researches on the properties of dielectrics, particularly rubber and petroleum. During World Wars I and II, he directed extensive programs in ballistic research for the Navy.

Since his retirement Dr. Curtis has maintained an active association with the Bureau, coming to his desk almost daily. His continued interest in ballistics is shown by the publication in 1948 of a paper entitled "An Instrument for the Rapid Production of a Decimal Series of Potentials and its Application to Ballistics Measurements," of which he was coauthor with Howard S. Roberts. He also published a paper in 1950 on the "Determination of Curvature by an Osculometer." His continued interest in absolute electrical measurements led to publication in 1949 of a paper on that subject in the Scientific Monthly.

He has long been concerned with science education, and his retirement permitted him to prepare, after a lapse of over 40 years, a historical paper on the establishment of accredited graduate courses at the National Bureau of Standards. This paper was published in this JOURNAL in 1949. In 1906, the year before Dr. Curtis joined its staff, the Bureau had established a system of courses at the graduate level—the first such courses in government. Dr. Curtis was soon asked to serve as chairman of the committee which arranged this curriculum. His studies as a postgraduate student at NBS helped qualify him for his own doctorate.

Since retiring, Dr. Curtis founded a unique organization, "The Fossils." These retired Government workers hold weekly meetings for fellowship and for discussions of subjects of mutual interest. They also make trips to places of historical and National interest around Washington.

Dr. Curtis was born December 14, 1875, on a farm near Lansing, Mich. He received his bachelor of philosophy degree from the University of Michigan in 1900 and his master of arts degree in 1903. He became a physics instructor at the Michigan Agriculatural College in 1903 and held the post of assistant professor there until he joined the National Bureau of Standards in 1907. He took his doctorate at the University of Michigan in 1910. In 1915, after demonstrating his ability for making electrical measurements with high precision, Dr. Curtis was appointed a section chief to direct part of the Bureau's electrical work. He continued to serve as a section chief until his retirement.

During his active career he gave generously of his spare time to scientific societies. He has served as president of the Philsophical Society of Washington and of the Washington Academy of Sciences and was chairman of the Washington section of the American Institute of Electrical Engineers. He is an honorary member of the American Society for Testing Materials, having served as chairman of Committee D-9 on Electrical Insulating Materials and as chairman of American Standards Association Technical Committee C-59 which is sponsored by ASTM. As a Fellow of the American Institute of Electrical Engineers, he was active in the National Affairs of that organization and also the American Physical Society. Dr. Curtis was made an honorary Phi Beta Kappa when the chapter was established at the University of Michigan in 1930. He is at present hard at work on his memoirs.

Dr. HERBERT FRIEDMANN, curator of the Division of Birds, U. S. National Museum, Smithsonian Institution, has been awarded the 1955 Leidy medal of the Academy of Natural Sciences of Philadelphia. The medal is awarded every three years for the best publication, exploration, discovery, or research in the natural sciences in such particular branches thereof as may be designated.

Dr. Friedmann is being honored for his research in ornithology, his study of the biology of parasitic birds, the monographic works he has published dealing with them, and the discovery of wax digestion by honey guides. His study of these small birds, which lead men and animals to nests of bees, may provide a new means of attacking the tubercle bacillus.

It may be noted that Dr. Friedmann is the author of the first number in the Academy's monograph series, *The Parasitic Cuckoos of Africa.*

OLIVER H GISH has been appointed visiting professor of physics at Southern Illinois University for the academic year 1955–56. From 1922 until his retirement in 1948, Gish was on the staff of the department of terrestrial magnetism of the Carnegie Institution of Washington, first as physicist and later as chief of the section of terrestrial electricity and as assistant director of the department. Since his retirement, he has been part-time consulting physicist to the U. S. Air Force and the U. S. Navy Mine Defense Laboratory.

R. N. DOETSCH, associate professor of bacteriology at the University of Maryland, has been appointed a 1956 fellow of the John Simon Guggenheim Foundation at the Rowett Research Institute, Bucksburn, Aberdeenshire, Scotland. He will work with A. E. Oxford on some aspects of rumen microbiology.

SHIRLEIGH SILVERMAN, of the Applied Physics Laboratory, Johns Hopkins University, has taken a year's leave, effective November 1, to serve as director of the Physical Sciences Division, Office of Naval Research.

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